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BULLETIN OF THE UNIVERSITY OF KANSAS
Vol. XII. April 15, 1911. No. 11

School of Engineering.

Announcements for 1911-'12.

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UNIVERSITY OF ILLINOIS.

LAWRENCE, KANSAS.

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from July to December, inclusive, by the
University of Kansas.

Entered as second-class matter December 29, 1910, at the post office at Lawrence,
Kansas, under the act of July 16, 1894.
5695

1910.

JULY.

S	M	T	W	T	F	S
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AUGUST.

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JANUARY.

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FEBRUARY.

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APRIL.

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MAY.

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JUNE.

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UNIVERSITY CALENDAR.

Academic Year 1911-'12.

Sept. 13, Wednesday—First term begins.

Sept. 13, 14, 15 and 16, Wednesday, Thursday, Friday and Saturday—Examination of candidates for admission, and presentation of certificates from high schools, academies, and other institutions.

Sept. 15, Friday—General assembly of students and annual address, in University Hall, at 10 A. M.

Nov. 2, Thursday—Fall concert by University Orchestra.

Nov. 20, Monday—Second half-term begins.

Nov. 23 and 24, Thursday and Friday—Thanksgiving recess, begins Wednesday noon.

Dec. 5, Tuesday—Winter concert by University Glee Club.

Dec. 14 and 15, Thursday and Friday—Annual opera performance, School of Fine Arts.

Dec. 19, Tuesday, 8 P. M.—Christmas concert by Music department, School of Fine Arts.

CHRISTMAS RECESS—Saturday, Dec. 23, to Friday, Jan. 5, inclusive, begins noon Friday, Dec. 22.

Jan. 5, Friday—Christmas recess ends.

Jan. 29 to Feb. 2, Monday to Friday, inclusive—Semiannual examinations.

Feb. 5, Monday—Second term begins.

Feb. 12, Monday, Lincoln's birthday—Legal holiday.

Feb. 22, Washington's birthday—Legal holiday.

March 7 and 8, Thursday and Friday—Annual opera performance, School of Fine Arts.

April 5 and 8, Friday and Monday—Easter recess, begins 5:30 P. M. Thursday.

March 29, Friday—First half-term ends.

April 1, Monday—Second half-term begins.

April 25 and 26, Thursday and Friday—Spring Music Festival.

May 27 to 31, Monday to Friday, inclusive—Annual examinations.

May 30, Thursday, Memorial Day—Legal holiday.

May 29, Wednesday—Commencement concert by Music department, School of Fine Arts.

June 2, Sunday, 8 P. M.—Baccalaureate sermon.

June 3, Monday, 8 P. M.—Sigma Xi address.

June 4, Tuesday, 10:30 A. M.—Annual Alumni address.

June 4, Tuesday, 8 P. M.—Chancellor's reception.

June 5, Wednesday, 10 A. M.—Commencement exercises.

June 6, Thursday—Opening of Summer Session.

CHRONOLOGICAL TABLE.

1855.—(December.) A university provided for in the first constitution of Kansas territory, at Topeka.

1857.—(June.) State University at Lawrence provided for by free-state legislature, Topeka.

1857.—(September.) Seminary of learning provided for in Lecompton constitution.

1858.—(April.) Systems of public instruction, including a university department, provided for in Leavenworth constitution.

1859.—(July.) State University provided for as at present, in Wyandotte constitution, now the constitution of the state of Kansas.

1861.—Congress set apart and reserved for the use and support of a State University seventy-two sections of land.

1863.—Lawrence selected as location for the University of Kansas.

1864.—The University organized by the legislature.

1865.—March 21, first meeting of the Board of Regents.

1866.—July 19, Regents elected the first Faculty of the University, consisting of Elial Jay Rice, A. M., David Hamilton Robinson, A. M., and Francis Huntington Snow, A. M.

1866.—North College erected.

1866.—September 12, first session of the University opened at North College.

1870.—Department of Engineering organized.

1872.—Fraser Hall erected and occupied.

1876.—Normal Department established.

1877.—Department of Music organized.

1878.—Department of Law organized.

1883.—Medical Hall (old Chemistry Building) erected.

1885.—Department of Pharmacy established.

1885.—Normal Department discontinued.

1886.—Snow Hall erected.

1891.—The Preparatory Department discontinued, the work being left to the high schools of the state.

1891.—The University reorganized and Schools of Arts, Engineering, Law, Fine Arts and Pharmacy established.

1894.—Spooner Library erected.

1894.—Chancellor's residence erected.

1895.—Blake Hall erected.

1896.—The Graduate School established.

1899.—The Fowler Shops erected.

1899.—The School of Medicine established.

1900.—Chemistry and Pharmacy Building erected.

1902.—Natural History Museum Building erected.

1904.—The name of the School of Arts changed to the College of Liberal Arts and Sciences.

1904.—Green Hall erected.

1905.—Full four-year course in medicine established.

1905.—Eleanor Taylor Bell Memorial Hospital erected.

1906.—Robinson Auditorium-Gymnasium erected.

1906.—Clinical Laboratory erected.

1907.—Civil and Mechanical Engineering Building erected.

1908.—Mining Engineering Building erected.

1908.—Power plant and laboratories erected.

1909.—The School of Education and The Division of University Extension established.

1911.—First wing of Administration Building erected.

BOARD OF REGENTS.

Chancellor FRANK STRONG, Lawrence	*Ex officio.*
Hon. WILLIAM A. WHITE, Emporia	Term exp. 1913
Hon. LEON S. CAMBERN, Erie	" " 1913
Hon. CHARLES F. FOLEY, Lyons	" " 1913
Hon. SCOTT HOPKINS, Horton	" " 1915
Hon. JAMES A. KIMBALL, Salina	" " 1915
Hon. RODNEY A. ELWARD, Castleton	" " 1915

Officers of the Board.

Chancellor FRANK STRONG	*President, ex officio.*
SCOTT HOPKINS	*Vice President.*
RODNEY A. ELWARD	*Secretary.*

COMMITTEES OF THE BOARD.

Buildings:
Messrs. White, Hopkins and Foley.

Grounds:
Messrs. Kimball, White and Elward.

Auditing:
Messrs. Elward, White and Cambern.

Clinical Department:
Messrs. Foley, Kimball and Hopkins.

Finance:
Messrs. Cambern, Elward and Foley.

Organization and Policy:
Messrs. Hopkins, Cambern and Kimball.

GENERAL INFORMATION.

THE GENERAL CATALOGUE of the University of Kansas is issued in the spring of each year. A copy will be sent free to any one desiring it.

SEPARATE CATALOGUES of the schools of the University are issued at the same time with the General Catalogue of the University. Separate catalogues will give complete information as to each school or department of the University. Prospective students of the Graduate School, the School of Engineering, the School of Fine Arts, the School of Law, the School of Pharmacy, the School of Medicine, the School of Education, the University Extension Division or the Summer Session will ask for the separate catalogue of the desired school.

THE ALUMNI CATALOGUE of the University is issued at intervals, giving a list of the graduates of the University. Copies are sent free to graduates and former students of the University.

THE UNIVERSITY NEWS BULLETIN and the PRESS BULLETIN are issued weekly from the mailing room, for the purpose of furnishing the newspapers, high-school students and others of the state items of interest regarding University affairs. They will be sent regularly, without charge, to any one who may express a desire to receive them.

A HIGH-SCHOOL MANUAL is issued at intervals, giving in detail the requirements for entrance to the different schools of the University, together with suggestions as to methods, courses of study, laboratory equipment, and a list of accredited high schools.

SPECIAL BULLETINS are issued during the University year covering topics of importance to the University and the schools and colleges of the state.

THE UNIVERSITY CALENDAR is posted weekly upon the local bulletin board, announcing lectures, concerts, prizes, and other matters of public interest under the auspices of the University, and as soon as possible will be printed in sufficient numbers for distribution, on request, to high schools of the state and to graduates and former students.

For catalogues and other information, address

THE REGISTRAR,
UNIVERSITY OF KANSAS,
Lawrence, Kan.

OFFICERS OF INSTRUCTION
AND ADMINISTRATION.

The School of Engineering.

Frank Strong, A. B., 1884, A. M., 1893, Ph. D., 1897, (Yale); LL. D., 1909, (Baker University). Chancellor of the University, and President of the Faculties, *1902*.*
(101 F.†) 1345 Louisiana.

William Herbert Carruth, A. B., 1880, (University of Kansas); A. M., 1889, Ph. D., 1893, (Harvard). Vice President of the Faculties, and Professor of Germanic Languages and Literatures, 1882; *1879*.
(303 F.) 1342 Louisiana.

Frank Olin Marvin, A. B., 1871, A. M., 1874, (Allegheny). Dean of the School of Engineering, and Professor of Civil Engineering, 1882; *1875*.
(112 E.) 1603 Massachusetts.

Edgar Henry Summerfield Bailey, Ph. B., 1873, (Yale); Ph. D., 1883, (Illinois Wesleyan). Professor of Chemistry and Metallurgy, and Director of Chemical Laboratories, *1883*.
(214 C.) 1101 Ohio.

Charles Graham Dunlap, A. B., 1883, A. M., 1899, (Ohio Wesleyan); Litt. D., 1892, (Princeton). Professor of English Literature, 1890; *1887*.
(301 F.) 925 Kentucky.

Erasmus Haworth, B. S., 1881, M. S., 1884, (University of Kansas); Ph. D., 1888, (Johns Hopkins). Professor of Geology, Mineralogy, and Mining, and Superintendent of the Geological Survey, 1894; *1892*.
(Min.) 1503 Massachusetts.

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* The date after each title indicates the year of appointment to the present rank; a second date denotes the year of first appointment in the University, when that fact is not indicated by the first date.

† Abbreviations:
B=Blake Hall.
C=Chemistry Building.
D=Dick Building Studios.
E=General Engineering Building.
F=Fraser Hall.
G=Green Hall.
L=Spooner Library.
Min=Mining Building.
M=Medical Hall.
Mu=Museum of Natural History.
N=North College.
RG=Robinson Gymnasium.
S=Snow Hall.
Sh=Fowler Shops.
ML=Mechanical Laboratory.
PP=Power Plant.

EUGENIE GALLOO, B. L., 1892, (University of Michigan); Académie de Paris, Brevet, 1881, Sorbonne, 1884, (University of France); A. M., 1895, (University of Kansas). Professor of Romance Languages and Literatures, 1900; *1892.*
(304 F.) 1324 Louisiana.

PERLEY F. WALKER, B. M. E., 1896, (University of Maine); M. M. E., 1901, (Cornell). Professor of Mechanical Engineering, 1906; *1905.* (211 E.) 1301 Ohio.

ROBERT KENNEDY DUNCAN, A. B., 1892, (Toronto). Director of Industrial Research, with rank of Professor, 1910; *1906.*
(102 C.)

GEORGE CARL SHAAD, B. S., 1900, M. S., 1905, (Penn. State College). Professor of Electrical Engineering, *1909.*
(15 E.) University Heights.

JOHN WESLEY YOUNG, A. B., 1899, (Ohio State University); A. M., 1901, PH. D., 1904, (Cornell University). Professor of Mathematics, 1910. (104 B.) 1702 Massachusetts.

ELMER FRANKLIN ENGEL,* A. B., 1892, (University of Kansas); A. M., 1898, (Harvard). Associate Professor of German, 1905; *1892.* (103 E.) 1211 Kentucky.

HAMILTON PERKINS CADY, A. B., 1897, PH. D., 1903, (University of Kansas). Associate Professor of Chemistry, 1905; *1899.*
(115 C.) 1535 Kentucky.

MARTIN EVERETT RICE, B. S., 1891, M. S., 1893, (University of Kansas). Associate Professor of Physics and Electrical Engineering, 1906; *1892.* (204 B.) 1223 Vermont.

WILLIAM CHRISTIAN HOAD, B. S., 1898, (University of Kansas). Associate Professor of Civil Engineering, 1906; *1900.*
(209 E.) 1043 Indiana.

JOHN NICHOLAS VAN DER VRIES, A. B., 1896, A. M., 1899, (Hope); PH. D., 1901, (Clark). Associate Professor of Mathematics, 1906; *1901.* (108 E.) 1644 New Hampshire.

B J DALTON, B. C. E., 1890, (University of Kansas). Associate Professor of Civil Engineering, *1906.* (118 E.) 1011 Indiana.

CLINTON MASON YOUNG, B. S. in Mining, 1904, E. M., 1909, (Case). Associate Professor of Mining Engineering, *1906.*
(H.) 1227 Ohio.

HERBERT ALLAN RICE, C. E., 1897, (Ohio State University). Associate Professor of Civil Engineering, *1905.*
(202 E.) 1304 Ohio.

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* Absent on leave, 1910-'11.

FRANK EMERSON WARD, (Northern Indiana Normal School). Superintendent of Fowler Shops and Shop Instruction, 1899; *1889.*
(Sh.) 1236 Oread Ave.

FREDERICK NEWTON RAYMOND, A. B., 1896, (University of Kansas); A. M., 1897, (Columbia). Assistant Professor of Rhetoric, *1901.*
(107 E.) 811 Mississippi.

GEORGE JUSSEN HOOD, B. S., 1902, (University of Kansas). Assistant Professor of Mechanical Drawing, *1902.*
(302 E.) University Heights.

RALPH EMERSON BASSETT, A. B., 1889, A. M., 1890, (Harvard). Assistant Professor of Romance Languages, 1910; *1913.*
(103 E.) 746 Ohio.

CHARLES IVES CORP,* B. S., 1903, (University of Kansas). Assistant Professor of Mechanical Engineering, *1904.*
(10 E.) ———.

JAMES DYNAN NEWTON, A. B., 1891, A. M., 1895, (Holy Cross); M. E., 1895, (Cornell). Assistant Professor of Civil Engineering, *1906.*
(302 E.) 1536 New Hampshire.

CHARLES COCHRAN, B. S., (University of Colorado). Assistant Professor of Mechanical Drawing, *1906.*
(302 E.) 1336 Kentucky.

FRANK EVERETT JONES, (Armour Institute). Assistant Professor of Carpentry and Pattern Making, *1903.*
(Sh.) 1324 New Hampshire.

ALFRED HIGGINS SLUSS, B. S. in Mech. Eng., 1901, (University of Illinois). Assistant Professor of Mechanical Engineering, *1908.*
(305 E.) 1133 Kentucky.

HARRY GARDNER, B. S. in General Engineering, 1905, (University of Wisconsin). Assistant Professor of Sanitary Engineering, *1909.*
(209 E.) 940 Indiana.

EDWARD MAURICE BRIGGS, A. B., 1904 (University of Nebraska); A. M., 1908, (University of Kansas). Assistant Professor of German, *1906.*
(103 E.) 1234 Oread Ave.

ARTHUR DUNN PITCHER, A. B., 1906, A. M., 1907, (University of Kansas); PH. D., 1910, (University of Chicago). Assistant Professor of Mathematics, 1910.
(108 E.) 325 Indiana.

EDGAR LEMUEL TAGUE, A. B., A. M., 1908, (University of Kansas). Assistant Professor of Chemistry, 1910.
(310 C.) 1139 Tennessee.

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* On leave.

Herman Camp Allen, A. B., 1904, (McPherson College); A. M., 1905, (University of Kansas). Assistant Professor of Chemistry, 1910.
(204 C.) 808 Mississippi.

Clarence Anthony Johnson, B. S., 1906, (University of Nebraska). Instructor in Electrical Engineering, 1909; *1908*.
(15 E.) 926 Indiana.

Howard Ashley Parker. Instructor in Civil Engineering, *1909*.
(306 E.) 1011 Indiana.

Arthur Bowes Frizell, A. B., 1893, A. M., 1900, (Harvard). Instructor in Mathematics, *1909*.
(108 E). 1247 Kentucky.

May Gardner, A. B., 1897, (University of Kansas). Instructor in French, *1909*.
(103 E.) 627 Connecticut.

William Eben Schultz, A. B., 1906, (Christian College); A. M., 1909, (Yale). Instructor in Rhetoric, *1909*.
(107 E.) 945 Vermont.

Edward Albert White,* B. S., 1908, (University of Kansas). Instructor in Mechanical Engineering, 1910.
(10 E.) 945 Illinois.

Benjamin Franklin Stelter, A. B., 1905, A. M., 1908, (University of Kansas). Instructor in English, 1910.
(107 E.) 1201 Tennessee.

Grorge Wellman Hess, A. B., 1906, (Kalamazoo College). Instructor in Mathematics, 1910.
(E.) 1501 Rhode Island.

Ephraim Edgar Landrum. Assistant Instructor in Woodworking, 1909.
(Sh.) 931 Maine.

Wilber Abram Hobbs, A. B., 1910, (University of Kansas). Assistant Instructor in Chemistry, 1910.
(C.) 909 Maine.

Walter Bohnstengel, B. S., 1910, (University of Kansas). Laboratory Assistant in Mechanical Engineering, 1910.
(M. L.) 1111 Kentucky.

Victor Lednicky. Laboratory Assistant in Mining Engineering, 1910.
(H.) 1339 Kentucky.

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* In Professor Corp's place for the year 1910-'11.

The School of Engineering.

PURPOSE OF THE SCHOOL.

The School of Engineering is the scientific or technical school of the University. It offers what is, in the main, technical training in the various departments of engineering—civil, electrical, mechanical, mining, sanitary, and chemical. The course of study in each of these branches of engineering is designed first of all to furnish a broad and thorough training in mathematics, mechanics, drawing, and physical science, the fundamental subjects on which the more professional subjects are based. The six courses are alike during the first year, and are nearly identical up to the end of the Sophomore year, but differ considerably thereafter, each emphasizing the subjects peculiar to itself and giving as much technical training as is consistent with the thorough inculcation of sound theory.

DEGREES.

All courses in the School of Engineering lead to the degree of bachelor of science. All work for higher degrees is under supervision of the Faculty of the Graduate School. The degree of master of science is granted to graduates in engineering after completion of one year's work in residence.

Graduates in engineering in this University, and masters of science who have received their degrees through the Graduate Faculty, are eligible to the professional degrees of civil engineer, electrical engineer, mechanical engineer, mining engineer, or chemical engineer, whichever is appropriate to the undergraduate course taken. Candidates for these degrees must have spent at least three years' actual time in professional practice, in positions of responsibility, in the design, construction or operation of engineering works, and must furnish detailed and satisfactory evidence as to the nature and extent of this practice.

They must submit an engineering thesis, accompanied by detailed explanations, drawings, specifications, estimates, etc., and embodying the results of their own work or observation. If approved, the thesis and all acompanying material become the property of the University.

All theses for any professional degree must be delivered to the Dean of the School of Engineering on or before May 15.

ADMISSION.

There are two methods of admission to the School of Engineering of the University: first, by examination; second, by certificate.

1. BY EXAMINATION.

Times and place of examination for admission to the School of Engineering are the same as for admission to the College. Candidates may divide the examination between two years, as noted.

2. BY CERTIFICATE.

Nearly all students enter the School of Engineering by certificate from high schools, academies, preparatory schools of other colleges and universities, or from military schools, accredited by the University. The candidate for admission by certificate must present either a certificate or other credential, as noted in connection with admission to the College. In general, the same rules apply in regard to admission by certificate to the School of Engineering as apply for admission to the College.

SUBJECTS FOR ADMISSION.

Fifteen units are required for admission.

REQUIRED.	
Mathematics 1, 2, 3, algebra and plane and solid geometry,	3 units.
English 1, 2, 3,	3 “
Physics,	1 “
Free-hand or mechanical drawing,	1 “
Foreign language—may be French or German or Latin; 3 units of one, or 2 units of any one and 1 unit of any other,	3 “
Required,	11 units.
Optional,	4 “
Total,	15 units.

OPTIONAL.	
Latin 1, 2, 3,	3 units
German 1, 2, 3,	3 “
French 1, 2, 3,	3 “
Greek 1, 2, 3,	3 “
Greek and Rom. hist.,	1 “
Mediæval and modern history,	1 “
English history,	1 “
American history,	1 “
Chemistry,	1 “
Higher algebra,	½ “
Plane trigonometry,	½ “
Physical geog.,	½ or 1 “
Botany,	1 “
Physiology,	1 “
Zoölogy,	1 “
Economics,	½ or 1 “
Manual training,	1 “

Four units must be chosen from the optional list.

DEFICIENCIES AND UNITS OF ADMISSION.

The candidate may be admitted to the Freshman class although deficient in some of the requirements as laid down above, provided such deficiency does not exceed two units. All deficiencies must be made good within such time as may be fixed in each individual case by the Dean of the School of Engineering.

Applicants for admission are advised to come without deficiencies, and to be especially well prepared in algebra and geometry.

An entrance unit represents five periods a week, of not less than forty minutes each, for thirty-five weeks. A unit in the School of Engineering represents five periods a week for a half-year. In making up deficiencies in University classes, one School of Engineering unit is counted as equivalent to one entrance unit.

ADVANCED CREDIT.

Advanced credit for work in preparatory schools will be given upon examination only. For times and place of such examination, see under "The College."

ACCREDITED SCHOOLS.

The list of schools accredited to the School of Engineering is practically the same as that of schools accredited to the College.

ADMISSION TO ADVANCED STANDING.

For any advanced rank, the applicant must have completed all of the studies of the course below the rank for which he applies, including the entrance requirements, or their substantial equivalent, as determined by the committee on advanced standing. Application for credits toward advanced standing should be made to the Dean of the School of Engineering.

SPECIAL STUDENTS.

Opportunity is given in the School of Engineering for the admission of persons of mature years who desire to pursue some special line of work, without following any prescribed course or becoming candidates for a degree.

The admission of such special students is directly under the control of the Dean of the School of Engineering, whose certificate of acceptance must be presented to the Registrar before registration. Applicants for standing as special students must present satisfactory evidence of proper preparation for the studies desired, and must also meet other requirements as fixed by the Faculty.

Special students are subject to the same regulations as regular students with regard to the quality of work performed and attendance at recitations and examinations, but not as to number of studies to be pursued.

REGISTRATION AND ENROLLMENT.

All candidates for admission to the School of Engineering having high-school certificates, and all students intending to pursue their studies in the ensuing year, must present themselves for registration at the University on September 13 to 16, inclusive, 1911. Registration at a later date will be permitted only on the presentation of a satisfactory reason for the delay. Preliminary registration may be made through the mails by forwarding to the Registrar a certified transcript of preparatory work, this registration to be completed by the Registrar during the opening week of the following semester.

The Dean of the School of Engineering is charged with the execution of all University and Faculty rules relating to the enrollment of students in classes and their choice of studies.

Upon registration, each student will receive from the Registrar a certificate of his standing, which he will present to the Dean of the School, who is charged with the duty of enrollment of students in classes, the selection and arrangement of subjects, and the assignment of hours.

At least two weeks before the close of any term, each student then in attendance must present his application for enrollment for the term following to the Dean, whose approval of the work selected is a necessary condition for admission to classes.

INADEQUATE PREPARATION.

When students show by their current work insufficient entrance preparation in any study, they may be required to make good such deficiency in any manner prescribed by their instructors.

GRADES AND FAILURES.

Examinations are held at regular stated periods and at such other times as may be provided for by the regulations of the Faculty. At the close of each semester, a summary of the student's work is reported to the Registrar, for entry upon the general record. At the end of each semester, the parent or guardian of each student will be furnished, on request, a copy of the entries relating to that student.

Absence from examination or failure in more than one-third of his work in any one semester severs a student's connection with the University, which can only be renewed through the consent of the Dean of the School.

Any withdrawal from school or from any class must be authorized by the Dean; otherwise such absence will be construed as failure.

EXPENSES OF STUDENTS.

FEES.

By legislative enactment students are required to pay fees as scheduled below. In all cases the matriculation fee is paid but once—at the time the student first registers in the College or in any school of the University. The incidental fee is payable in full each year at registration, but students in the schools of Law, Pharmacy, and Medicine are permitted to pay one-half of the incidental fee at the beginning of each term.

Matriculation fee, for residents of the state	$5 00
for nonresidents	10 00
Incidental fee, for residents of the state	10 00
for nonresidents	20 00
Diploma fee, at graduation	5 00

Those students taking summer field work will be charged the actual cost of living and incidental expenses.

PROGRAM OF STUDIES.

Leading to the degree of Bachelor of Science.

The courses of study in the School of Engineering are almost entirely required. The work is in the main technical, and requires preparation of a high order, especially in mathematics. It also requires continuous effort in the courses themselves, which call for the entire time of the student to satisfactorily succeed.

The work of the Freshmen year is common to all students of the School of Engineering, so that a choice between the several lines of engineering need not be made until after a year's experience with college life. As a further aid in making an intelligent choice, the general aims of the several courses are here briefly stated.

CIVIL ENGINEERING.

The first aim is to impart as broad a scientific training as the length of the course and the essential professional studies will allow, so that as many avenues to successful service as possible may be open to the graduate. Along professional lines, emphasis is laid first on work in surveying and field methods, as these are of special value to young engineers; second, on mechanics and its applications to the design of roofs and bridges and other structures; third, on railway location and construction; fourth, on hydraulics and its applications to irrigation and canal work; fifth, on sanitary and municipal engineering, including water supply, sewerage, and roads and pavements. Stress is placed on the study of principles, as being the things not likely to be acquired in after-life.

MUNICIPAL AND SANITARY ENGINEERING.

This course is a modification of the course in civil engineering, and is intended for those desiring a more extensive study and a more thorough training in general sanitary science and in municipal and sanitary engineering practice. The program of study is practically the same is in civil engineering, except that during the Junior and Senior years the railroad work and the work in bridge designing are replaced by studies more closely related to public sanitation and municipal engineering practice.

This new added work includes a somewhat specialized course in bacteriology, particularly in its relation to water supply and sewerage; a short lecture and laboratory course in the chemical analysis of water; a broad and general study of sanitary science as related to public health problems; courses in the design of engineering structures related to sewage disposal and water purification; and a study of the theory and practice of reinforced concrete construction. The course also aims, by means of work in the sanitary laboratory and engineering experiment station, by visits of inspection to engineering works of interest to sanitary engineers, and by means of papers and informal discussions in the journal meetings, to train the student's judgment in regard to sanitary problems, and to strengthen his grasp upon the regular classroom studies.

ELECTRICAL ENGINEERING.

The course in electrical engineering is designed to train the student in those fundamental principles of applied mathematics, physics, chemistry, mechanics and electricity which form the basis of all successful engineering work. The laboratory and shop work is arranged to develop and to encourage individual skill and ingenuity. Such experience in practical electrical work as is possible is also included in the course. The aim of the entire course is to develop in the student those qualities that are essential to the professional engineer as well as those that are essential to the electrical artisan. The thesis involves original investigation.

MECHANICAL ENGINEERING.

In addition to the fundamental sciences common to all branches of engineering, this course offers professional work for students wishing to specialize in steam and gas engineering or mill engineering.

For the first branch the special work includes the designing of steam and gas engines and steam turbines, and a study of methods of power distribution and application by both mechanical and electrical means. Complete power-plant designs are made, both for the generation of electrical power and for direct use in manufacturing plants, and students become familiar with all forms of steam, gas, air-compressor, hydraulic and electrical machinery through their study and operation in the laboratories.

For mill engineering, the special work includes the designing of mill or shop buildings, traveling cranes, etc., and power distribution systems. It is intended to suit the needs of prospective engineers and managers of manfacturing plants of all kinds.

MINING ENGINEERING.

The object of the course in mining is to qualify students for future work in prospecting, mining, milling, and smelting, in accordance with modern scientific principles. In adopting the course of study, it was endeavored to include a sufficient requirement in language work to give the student a good knowledge of French, German and English, and to adjust the various essential subjects—mathematics, engineering, chemistry, metallurgy, mining, mineralogy, and geology—so that upon the completion of the course one may be well qualified for specializing along any line which his future life may make desirable.

CHEMICAL ENGINEERING.

This course affords students an opportunity to specialize in chemistry, and to fit themselves for positions as chemists, managers or superintendents of manufacturing plants where the work is based on chemical science. This would include such industries as that of iron, zinc, gold and silver smelting and refining, the making of fertilizers, clay working, sugar refining, dyeing, bleaching, gas making, cement making, and general chemical manufacture. This course is broad enough for general training, and may be made special enough for technical work.

WORK IN COMMON.

FRESHMAN YEAR.

All students of the School of Engineering have work in common during the Freshman year, the differentiation between courses occurring in the Sophomore year. In the statement of courses below, following each subject is stated the number of credits given to it; (*a*) and (*b*) signify first and second half-terms.

The modern foreign language chosen must be carried throughout the year, five hours each term. The grade of the courses will depend on the amount and kind of language offered for entrance.

First Semester:

Rhetoric 1E, three credits.
Mechanics 1, two credits.
French, German, or Spanish, five credits.
College Algebra (Mathematics 2), three credits.
Plane Trigonometry (Mathematics 3), two credits.
Free-hand Drawing (Mechanical Drawing 1), six hours for first six weeks of term. One credit.
Mechanical Drawing 2, six hours for last fourteen weeks of term. Two credits. Same days and hours as for free-hand drawing.
Shop Work 1 or 2, five hours. Two and one-half credits.

Second Semester:

French, German, or Spanish, five credits.
Analytical Geometry I (Mathematics 4), two credits.
Calculus I (Mathematics 5), three credits.

Descriptive Geometry (Mechanical Drawing 3), three credits.
Rhetoric 2E, two credits.
Machine Drawing (Mechanical Drawing 4), six hours. Three credits.
Shop Work 1 or 2, five hours. Two and one-half credits.

For irregular students, classes in English, Algebra and Trigonometry, Elementary Mechanics, French 1, German 1 and 3 and Spanish 1 are given in the second semester, and classes in Analytical Geometry, Descriptive Geometry, Calculus, French 2 and German 2 are given in the first semester.

CIVIL ENGINEERING.

SOPHOMORE YEAR.

First Semester:
Physics 1E, lectures and recitations four hours and laboratory two hours. Five credits.
Chemistry 2, lectures and recitations three hours and laboratory two hours. Four credits.
Calculus II (Mathematics 7), three credits.
Analytical Geometry II (Mathematics 6), two credits.
Stereotomy (Civil Engineering 4), six hours. Three credits.
Shop Work 3, five hours. Two and one-half credits.
One technical report. One-half credit.

Second Semester:
Physics 2E, lectures and recitations four hours and laboratory two hours. Five credits.
Surveying (Civil Engineering 2), four hours, and field work once a week. Five credits.
Qualitative Analysis (Chemistry 3), lectures two hours and laboratory four hours. Four credits.
Topographical Drawing (Civil Engineering 1), six hours. Three credits.
Shop Work 4, five hours. Two and one-half credits.
One technical report. One-half credit.

Summer Vacation:
Surveying (Civil Engineering 3). Four weeks.

JUNIOR YEAR.

First Semester:
Mechanics 50, five credits.
Advanced English Composition (English Language 50E), three credits.
Geology 1, five credits.
Railway Surveying (Civil Engineering 58), four hours, and field work once a week. Five credits.
Railway Drawing (Civil Engineering 50), six hours. Three credits.

Second Semester:

Strength of Materials (Mechanics 51), four credits.

Engines and Boilers (Mechanical Engineering 53), three credits.

Location of Railways (Civil Engineering 57), three credits.

Roads and Pavements (Civil Engineering 56), two credits.

Graphical Statics (Civil Engineering 51), six hours. Three credits.

Testing Laboratory (Mechanics 52), four hours. Two credits.

One technical report. One-half credit.

Summer Vacation:

Surveying (Civil Engineering 53). Four weeks.

SENIOR YEAR.

First Semester:

Hydraulics (Mechanics 53), (*a*), four hours. Two credits.

Hydraulic Machinery (Mechanical Engineering 56), (*b*), four hours. Two credits.

Sewerage (Civil Engineering 59), (*a*), five hours. Two and one-half credits.

Waterworks (Civil Engineering 60), (*b*), five hours. Two and one-half credits.

Roofs and Bridges (Civil Engineering 61), ten hours. Five credits.

Hydraulic Laboratory (Mechanics 54), two hours. One credit.

Thesis, two and one-half hours, by appointment.

One technical report. One-half credit.

Second Semester:

Bridge Designing (Civil Engineering 62), ten hours. Five credits.

Specifications and Contracts (Civil Engineering 52), (*b*), five hours. Two and one-half credits.

Masonry (Civil Engineering 55), (*a*), five hours. Two and one-half credits.

Cement Laboratory (Civil Engineering 54), four hours. Two credits.

Optional. One full semester's work chosen from engineering, mathematical or scientific subjects not required in course. Five credits.

Thesis, two and one-half hours, by appointment.

MUNICIPAL AND SANITARY ENGINEERING.

SOPHOMORE YEAR.

(Same as in Civil Engineering.)

JUNIOR YEAR.

First Semester:

Mechanics 50, five credits.

Advanced English Composition (English Language 50E), three credits.

Geology 1, five credits.

Sewerage (Civil Engineering 59), (*a*), five hours. Two and one-half credits.

Waterworks (Civil Engineering 60), (*b*), five hours. Two and one-half credits.

Municipal Engineering Drawing (Civil Engineering 67), six hours. Three credits.

Sanitary Engineering Journal Meeting, one hour.

Second Semester:

Strength of Materials (Mechanics 51), four credits.

Engines and Boilers (Mechanical Engineering 53), three credits.

Water Analysis (Chemistry 56), six hours. Three credits.

Roads and Pavements (Civil Engineering 56), two credits.

Street Cleaning and Garbage Collection and Disposal (Civil Engineering 68), one credit.

Testing Laboratory (Mechanics 52), four hours. Two credits.

Sanitary Engineering Journal Meeting, one hour.

One technical report. One-half credit.

Summer Vacation:

Summer Field Work (Civil Engineering 53). Four weeks.

SENIOR YEAR.

First Semester:

Hydraulics (Mechanics 53), (*a*), four hours. Two credits.

Hydraulic Machinery (Mechanical Engineering 56), (*b*), four hours. Two credits.

Water Bacteriology (Botany 50E), six hours. Three credits.

Sanitary Science and Public Health Problems (Civil Engineering 69), (*a*), five hours. Two and one-half credits.

Roofs and Bridges (Civil Engineering 61), ten hours. Five credits.

Sanitary Engineering Laboratory (Civil Engineering 70), two hours. One credit.

Hydraulic Laboratory (Mechanics 54), two hours. One credit.

Thesis, two and one-half hours, by appointment.

Sanitary Engineering Journal Meeting, one hour.

One technical report. One-half credit.

Second Semester:

Sanitary Engineering Design (Civil Engineering 64), five credits.

Specifications and Contracts (Civil Engineering 52), (*b*), five hours. Two and one-half credits.

Masonry (Civil Engineering 55), (*a*), five hours. Two and one-half credits.

Reinforced Concrete (Civil Engineering 65), (*b*), five hours. Two and one-half credits.

Cement Laboratory (Civil Engineering 54), four hours. Two credits.

Sanitary Inspection and Reports (Civil Engineering 72), one hour.

Thesis, two and one-half hours, by appointment.

Sanitary Engineering Journal Meeting, one hour.

ELECTRICAL ENGINEERING.

SOPHOMORE YEAR.

First Semester:

Physics 1E, lectures and recitations four hours, and one two-hour laboratory period per week. Five credits.

Calculus II (Mathematics 7), three credits.

Analytic Geometry II (Mathematics 6), two credits.

Chemistry 2, lectures three hours and laboratory two hours. Four credits.

Machine Drawing (Mechanical Engineering 1), six hours. Three credits.

Shop Work 3, five hours, one day per week. Two and one-half credits.

One technical report. One-half credit.

Second Semester:

Qualitative Analysis (Chemistry 3), lectures two hours and laboratory four hours. Four credits.

Physics 2E, lectures and recitations four hours, one two-hour laboratory period per week. Five credits.

Kinematics (Mechanical Engineering 2), six hours. Three credits.

Steam Machinery (Mechanical Engineering 3). Two credits.

Mathematics 9E, two credits.

Shop Work 4, five hours, one day per week. Two and one-half credits.

One technical report. One-half credit.

JUNIOR YEAR.

First Semester:

Mechanics 50, five credits.

Theory of Electricity and Magnetism (Physics 52), three credits.

Thermodynamics (Mechanical Engineering 57), four credits.

Dynamo Machinery (Electrical Engineering 50), three credits.

Electrical Measurement (Physics 60E), four hours, two days per week, on alternate weeks. Two credits.

Electrical Laboratory (Electrical Engineering 54), four hours, two days per week, on alternate weeks. Two credits.

Shop Work 50, five hours, one day per week. Two and one-half credits.

One technical report. One-half credit.

Second Semester:

Mechanics of the Steam Engine (Mechanical Engineering 62), three credits.

Theory of Alternating Currents (Electrical Engineering 51), five credits.

Electrical Laboratory (Electrical Engineering 55), four hours, two days per week on alternate weeks. Two credits.

Electrical Measurements (Physics 61E), four hours, two days per week on alternate weeks. Two credits.

Strength of Materials (Mechanics 51), four credits.

Advanced English Composition (English Language 50E), three credits.

Testing Laboratory (Mechanics 52), four hours. Two credits.

SENIOR YEAR.

First Semester:

Dynamo Machinery (Electrical Engineering 52), five credits.

Physical Chemistry (Chemistry 64), five credits.

Surveying (Civil Engineering 71), three credits.

Electrical Laboratory (Electrical Engineering 56), six hours. Three credits.

Engineering Laboratory (Mechanical Engineering 60), four hours. Two credits.

Professional Thesis (Electrical Engineering 61), one hour, by appointment.

One technical report. One-half credit.

Second Semester:

Electric Power Transmission (Electrical Engineering 58), (*a*), five hours. Two and one-half credits.

Electric Railways (Electrical Engineering 60), (*b*), five hours. Two and one-half credits.

Electric Lighting (Electrical Engineering 57), (*a*), five hours. Two and one-half credits.

Contracts and Specifications (Civil Engineering 52), (*b*), five hours. Two and one-half credits.

Professional Thesis (Electrical Engineering 61), three hours, by appointment.

Optional work, five hours. This work is to be chosen from any engineering, physics or mathematics courses offered, subject to the approval of the head of the electrical engineering department. Five credits.

MECHANICAL ENGINEERING.

SOPHOMORE YEAR.

First Semester:

Physics 1E, lectures four hours and laboratory two hours. Five credits.

Calculus II (Mathematics 7), three credits.

Analytical Geometry II (Mathematics 6), two credits.

Chemistry 2, lectures three hours and laboratory two hours. Four credits.

Machine Drawing (Mechanical Engineering 1), six hours. Three credits.

Shop Work 3, five hours. Two and one-half credits.

One technical report. One-half credit.

Second Semester:

Physics 2E, lectures four hours and laboratory two hours. Five credits.

Qualitative Analysis (Chemistry 3), lectures two hours and laboratory four hours. Five credits.

Steam Machinery (Mechanical Engineering 3), two credits.

Calculus III (Mathematics 9E), two credits.

Kinematics (Mechanical Engineering 2), six hours. Three credits.

Shop Work 4, five hours. Two and one-half credits.

One technical report. One-half credit.

JUNIOR YEAR.

First Semester:

Mechanics 50, five credits.

Dynamo Machinery (Electrical Engineering 50), three credits.

Metallurgy I (Metallurgy 61), five credits.

Electrical Laboratory (Electrical Engineering 54), four hours, one day per week on alternate weeks. Two credits.

Engineering Laboratory (Mechanical Engineering 60), four hours. Two credits.

Shop Work 50, five hours. Two and one-half credits.

Second Semester:

Strength of Materials (Mechanics 51), four credits.

Machine Design (Mechanical Engineering 51), three credits.

Theory of Alternating Currents (Electrical Engineering 51), five credits.

Electrical Laboratory (Electrical Engineering 55), four hours, one day per week on alternative weeks. Two credits.

Testing Laboratory (Mechanics 52), four hours. Two credits.

Shop Work 51, five hours. Two and one-half credits.

One technical report. One-half credit.

Summer Vacation:

Summer Vacation Work (Mechanical Engineering 64). This course to be done before graduation.

SENIOR YEAR.

First Semester:

Advanced English Composition (English Language 50E). Three credits.

Hydraulics (Mechanics 53), (*a*), four hours. Two credits.

Hydraulic Machinery (Mechanical Engineering 56), (*b*), four hours. Two credits.

Hydraulic Laboratory (Mechanics 54), two hours. One credit.

Thermodynamics (Mechanical Engineering 57), (*a*), five hours, two and one-half credits.

Advanced Steam Engineering (Mechanical Engineering 58), (*b*), five hours. Two and one-half credits.

Steam-engine Design (Mechanical Engineering 50), (*a*), eight hours. Two credits.

Gas-engine Design (Mechanical Engineering 55), (*b*), eight hours. Two credits.

Alternating-current Machinery (Electrical Engineering 63). Two credits.

Thesis (Mechanical Engineering 63), two hours. One credit.

One technical report. One-half credit.

Second Semester:

Contracts and Specifications (Civil Engineering 52), (*b*), five hours. Two and one-half credits.

Engineering Practice (Mechanical Engineering 59). Two credits.

Designing (Mechanical Engineering 52), ten hours. Five credits.

Engineering Laboratory (Mechanical Engineering 61), four hours. Two credits.

Heating and Ventilation (Mechanical Engineering 54). Two credits.

Economic History of the United States (Economics 3). Three credits.

Thesis (Mechanical Engineering 63), four hours. Two credits.

MINING ENGINEERING.

SOPHOMORE YEAR.

First Semester:

Chemistry 2, lectures three hours and laboratory two hours. Four credits.

Calculus II (Mathematics 7), three credits.

Analytical Geometry II (Mathematics 6), two credits.

Elementary Geology (Geology 1), lectures and recitations five hours. Five credits.

Machine Drawing (Mechanical Engineering 1), six hours. Three credits.

Work Shop 3, five hours. Two and one-half credits.

Mining Journal Meeting, one hour.

One technical report. One-half credit.

Second Semester:

Qualitative Analysis (Chemistry 3), lectures two hours and laboratory four hours. Four credits.

Surveying (Civil Engineering 2), four hours, and field work once a week. Five credits.

Mineralogy (Mineralogy 1E), lectures, recitations and laboratory work, five credits.

Topographical Drawing (Civil Engineering 1), four hours. Two credits.

Mining Journal Meeting, one hour.

One technical report. One-half credit.

Summer Vacation:

Surveying (Civil Engineering 3), four weeks.

JUNIOR YEAR.

First Semester:

Physics 1E, lectures and recitations four hours, and laboratory, two hours. Five credits.
Economic Geology (Geology 52), three credits.
Mining 51, two credits.
Mining 50, five credits.
Quantitative Analysis (Chemistry 54), lectures and laboratory work, ten hours. Five credits.
Shop Work 4, five hours. Two and one-half credits.
Mining Journal Meeting, one hour.
One technical report. One-half credit.

Second Semester:

Physics 2E, lectures and recitations, four hours, and laboratory two hours. Five credits.
Assaying and Metallurgical Analysis (Metallurgy 57), ten hours. Five credits.
Mining 51, three credits.
Economic Geology (Geology 53), two credits.
Advanced English Composition (English Language 50E), three credits.
Mining Laws (Mining 57), lectures, one hour. (May be taken in Senior year.)
Mining Journal Meeting, one hour.

Summer Vacation:

Summer Excursion Work (Mining 59), four weeks.

SENIOR YEAR.

First Semester:

Mining 52,* five credits.
Mechanics 50, five credits.
Optional: Five credits from any geological, mathematical or engineering subjects not taken in the mining course.
Mining Journal Meeting, one hour.
One technical report. One-half credit.

Second Semester:

Strength of Materials (Mechanics 51), four credits.
Testing Laboratory (Mechanics 52), four hours. Two credits.
Metallurgy II (Metallurgy 62), five credits.
Mining 53, (*a*), five hours. Two and one-half credits.
Contracts and Specifications (Civil Engineering 52), (*b*), five hours. Two and one-half credits.
Professional Thesis (Mining 58).
Mining Law. (See Junior year.)
Mining Journal Meeting.

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* Mining 56 may be taken in place of Mining 52.

CHEMICAL ENGINEERING.

SOPHOMORE YEAR.

First Semester:

Physics 1E, lectures and recitations four hours and laboratory two hours. Five credits.

Chemistry 2, lectures three hours and laboratory four hours. Five credits.

Calculus II (Mathematics 7), three credits.

Analytical Geometry II (Mathematics 6), two credits.

Machine Drawing (Mechanical Engineering 1), six hours. Three credits.

Shop work 3, five hours. Two and one-half credits.

Chemical Club Meeting, one hour.

One technical report. One-half credit.

Second Semester:

Physics 2E, lectures and recitations four hours and laboratory two hours. Five credits.

Qualitative Analysis (Chemistry 3), lectures two hours and laboratory six hours. Five credits.

Mineralogy (Mineralogy 1E), ten hours. Five credits.

Shop work 4, five hours. Two and one-half credits.

Chemical Club Meeting, one hour.

One technical report, one-half credit.

JUNIOR YEAR.

First Semester:

Mechanics 50, five credits.

Advanced English Composition (English Language 50E), three credits.

Quantitative Analysis (Chemistry 54), twenty hours. Ten credits.

Chemical Club Meeting, one hour.

Second Semester:

Strength of Materials (Mechanics 51), four credits.

Testing Laboratory (Mechanics 52), four hours. Two credits.

Organic Chemistry (Chemistry 59), ten hours. Five credits.

Metallurgy II (Chemistry 62), five credits.

Chemical Club Meeting, one hour.

One technical report, one-half credit.

SENIOR YEAR.

First Semester:

Three optionals: Fifteen hours to be chosen from engineering, mathematical or science subjects not included in course, for which the student may have the requisite preparation. Fifteen credits.

Chemical Club Meeting, one hour.

One technical report, one-half credit.

Second Semester:

Specifications and Contracts (Civil Engineering 52), (*b*), five hours. Two and one-half credits.

Chemical Club Meeting, one hour.

Assaying and Metallurgical Analysis (Chemistry 57), ten hours. Five credits.

Thesis.

Physical Chemistry (Chemistry 65), five credits.

EQUIPMENT.

The School of Engineering is part of the general University, and hence the entire equipment of the University is also equipment of the School of Engineering in all things in which engineering students are concerned. The work of the Engineering School which is common to several schools of the University, such as mathematics, physics, chemistry, languages, etc., is carried on to some extent in buildings and by departments of instruction not exclusively for engineering students; while such work of the School as is technical and exclusively engineering in character is carried on by departments of instruction primarily for engineering students and largely in buildings erected for the special work of the School. Below will be described that part of the general equipment of the University which pertains chiefly to the work of this School. For other equipment, see under the College and other schools of the University.

BUILDINGS.

The buildings erected exclusively for engineering work are the Engineering Building, the Mechanical Laboratory in connection with the Power Plant, and the Fowler Shops. The work in mining is provided for in the Geology and Mining Building. For description of these buildings, see under the heading "Buildings and Grounds."

LIBRARIES.

The scientific portion of the general University library is available for the use of engineering students. That portion of direct interest to students of civil, sanitary, electrical and mechanical engineering is located in the library and reading room of Marvin Hall; those relating to geology and mining are to be found in the department library in Haworth Hall, and those of interest to chemical engineering students in the Chemistry Building. The leading technical journals are to be found in these various reading rooms.

DRAWING ROOMS.

In the Engineering Building there are six large, well-lighted drawing rooms, provided with individual tables containing drawers for each student's outfit and cabinets for drawing boards.

On the walls and contained in various print-cases are photographs of actual constructions, and large numbers of blue prints of working drawings for bridges, railway structures, sewers, waterworks, power and light stations, mine plants, etc.

LABORATORIES.

Numerous and well-equipped laboratories are provided for experimental work in engineering and scientific subjects. These laboratories and equipments are described in detail under the various engineering courses and scientific departments.

INSPECTIONS AND VISITS.

Occasional trips are made by advanced students and their instructors for the purpose of inspecting and studying various engineering works, such as large machine shops, power plants, lighting systems, steam and electric railways, city waterworks, sewerage systems, cement works, mining equipments, smelters, etc.

LECTURES AND SOCIETIES.

In each engineering course there is regularly maintained a journal meeting for the review of current engineering literature or a society for the discussion of engineering topics. These societies are described more fully under the heading of "University Organizations." Through the efforts of these societies and the members of the engineering Faculty, a large number of lectures by practical engineers are secured during the year.

CIVIL AND MUNICIPAL ENGINEERING.

The instruments for field work in civil engineering comprise transits, levels, compasses, solar attachments, rods, chains, tapes, plane tables, heliotropes, current meter, aneroids, and other minor instruments. Among the above are a precise level for very accurate leveling, a secondary triangulation transit for topographical work, and an altazimuth instrument for use on primary triangulations, which has a ten-inch circle, read to single seconds of arc.

For the summer work in surveying a complete camping outfit is provided. Planimeters, Thatcher and Manheim slide rules and Colby's stadia slide rules are used for rapid calculation and estimation of quantities.

The testing-of-materials laboratory, situated in the basement of the Engineering Building, is equipped for making tests on all kinds of structural materials.

The principal machines are a 200,000-pound Olsen universal testing machine capable of testing beams up to twenty feet in length and columns up to ten feet in height; two 100,000-pound and one 40,000-pound universal testing machines; a 50,000-inch-pound Olsen torsion machine; a 50,000-pound transverse machine; a White-Souther alternate-stress machine, and a standard rattler for testing paving brick. The laboratory is well equipped with small apparatus, such as extensometers, both direct-reading and autographic, compressometers, etc.

The concrete laboratory is provided with mixing machinery, molds for making test pieces, and apparatus for the mechanical analysis of sands and cements.

The cement laboratory has been completely equipped with new apparatus, and affords facilities for extended investigation work as well as for the current undergraduate courses.

The road-materials laboratory contains various machines for testing the strength, resistance to abrasion, and the cementing power of the dust of stone, the value of which as material for the building of rock roads is under investigation.

The hydraulic laboratory contains a measuring pit, a large steel orifice tank for experimentation with jets, a triplex power pump, two centrifugal pumps, pipe lines, weir boxes, gauges, a Venturi meter with manometer, a Pelton water motor, etc., arranged to illustrate the laws of fluid motion, and affording some opportunity for testing hydraulic machinery.

The sanitary laboratory is filled with apparatus for the investigation of water and sewage. It is not designed to supplant the chemical laboratories, but to afford means for making approximate and quick analyses for engineering purposes of samples suspected of contamination. The laboratory is also to be used in connection with research work along sanitary lines, in connection with an experimental plant for the treatment of the sewage from some of the University buildings.

ELECTRICAL ENGINEERING. .

The electrical engineering laboratories are located in the Engineering Building and comprise a dynamo laboratory, a standardizing laboratory, a photometer room, and space for the telephone equipment. The standardizing apparatus and the photometric equipment are entirely new. The dynamo laboratory was moved from Fowler Shops during the past year, and many new machines were added to its equipment.

The dynamo laboratory is now fitted with a complete line of both alternating and direct-current machines, the former varying in capacity from a two-horse power motor to a 50-kilowatt generator, while the direct-current machines range in capacity from one and one-half kilowats to 20 kilowats. These machines have been essentially selected with the view of supplying a complete set of experimental machines and to illustrate modern design and practice in dynamo-electric machinery. Individual motor drive is used for all experimental work and a chain hoist and trolley have been provided for use in quickly moving any of the machines to the position in which they may be required. Very few permanent connections are used, but the switchboards, connecting boards, and testing tables have all been especially designed to facilitate the connection of any piece of apparatus to a proper power supply. Direct current is supplied from the University power plant but all other voltage supply is through the agency of motor-generator sets in the laboratory. The machines in this room are also used as sources of current supply for the other electrical laboratories. The assortment of field and load rheostats, transformers, reactance coils, etc., is quite complete.

In the standardizing laboratory provision is made for the calibration of all types of electrical measuring instruments and for the study of problems in electrical measurements. The equipment consists of a potentiometer, and A. C.-D. C. comparator; laboratory standard ammeters, voltmeters, and wattmeters, a precise Wheatstone bridge; a portable testing set; an inductance bridge; and a three-element oscillograph. The above instruments are all equipped with a complete set of auxiliaries such that any ordinary range of potential or current in either direct or alternating currents may be measured. A storage battery is provided as a source of steady current for use in calibrating instruments. The portable instruments used in the dynamo laboratory are cared for in the standardizing room. This set of instruments is very complete and includes the best of foreign as well as American manufacture. In addition to the instruments in regular use this set contains portable meters of suitable types and ranges for the tests of power plants or of machines in regular commercial operation.

The photometer room is fitted with a 300-centimeter photometer bar, which is provided with necessary lamp holders and auxiliaries for the testing of the different types of lamps used in artificial illumination. A Bunsen screen, a Lummer-Brodum screen, and a flicker photometer have been provided for use in connection with this bar. A portable photometer of the Sharp-Miller type is used for studying the illumination of streets and buildings.

The telephone laboratory has an excellent assortment of modern telephone apparatus. This includes complete sets for illustrating installations, of both local battery and central energy types. The best selective systems are represented, as well as a complete small automatic telephone system.

MECHANICAL ENGINEERING.

The new mechanical laboratory is a room 48 by 100 feet, with a gallery 16 feet wide extending across one end and along one side about 60 feet. On the gallery floor are office, computing room, storeroom, instrument room, oil room fitted up with special apparatus for testing lubricants, and a fuel-testing room equipped with a Mahler bomb calorimeter, a Parr calorimeter, a Junker gas calorimeter, and apparatus for coal and gas analysis.

On the main floor are installed a 100-horsepower experimental boiler of Stirling water-tube type; an independently fired Foster superheater; a 10 x 24 x 30 cross-compound Monarch Corliss steam engine, equipped with Prony brake and also arranged to belt to a 55 K. W. direct-current generator; a 75-horsepower Ball automatic high-speed engine; a 20-horsepower De Laval steam turbine coupled to a centrifugal pump used for circulating water for the condenser; a 10-horsepower Atlas slide-valve engine; a C. H. Wheeler surface condenser of 600 square feet surface, equipped with wet and dry vacuum pumps; a 100-horsepower two-cylinder tandem Riverside gas engine direct-connected to the 55 K. W. generator above mentioned; two 8-horsepower gas or gasoline engines; a 75-horsepower Smith suction gas producer; a five-ton Cleveland ammonia compressor, motor driven, with submerged condenser and fittings complete, including a small ice box (can system), and an auxiliary brine cooler; several special lubricant-testing machines; a complete air-brake outfit for train service; and other minor pieces of apparatus. There will soon be installed a small refrigerating plant, a blower-testing outfit, and an automobile-testing plant. A very complete and representative outfit of engine indicators, steam calorimeters, etc., is owned by the department.

MINING ENGINEERING.

The new building for geology and mining was so planned as to give excellent opportunity for the concentration of ores. The ore-dressing laboratory, 40 x 80 feet, is connected to the main building by a corridor, and is so placed on a slope that the floor is divided into four steps, allowing ore to be carried from one floor to the other by gravity. The equipment consists of a stamp mill, jaw breaker, and a gyratory crusher, a power screen and hand screens, jigs, hydraulic classifiers, a Wilfley table, a Frue vanner, and various other pieces of apparatus, giving opportunities for practical training in the operation of concentrating machinery and the determination of the proper treatment of various ores. Apparatus for experimental work on the effect of coal washing has been recently installed. The mining museum contains models of mines and a collection of mills and apparatus used in mining and milling operations. A large and well equipped laboratory for testing clays is now under construction for the purpose of making a thorough and complete examination of the clays of Kansas.

CHEMICAL ENGINEERING.

The chemical laboratory contains separate rooms for general chemistry, qualitative analysis, quantitative analysis, physical chemistry; organic chemistry, metallurgy, and assaying. There are abundant specimens and samples of chemical products to use for illustration. For physical chemistry especially, the various instruments for electrical measurements are of new design and great accuracy. The department also has a liquid-air machine, so that experiments can be carried on at low temperatures. The assay room is provided with the usual furnaces, muffles, etc., for the complete assay of metallurgical products.

The laboratories for assaying and metallurgy are well equipped with gas, coke and gasoline muffle and crucible furnaces, with power grinding machinery, and with an assortment of pulp and button balances. In addition to this there are provided gas and coal calorimeters, a variety of pyrometers, apparatus for the microscopical examination of metals and for grinding sections, etc.

There are numerous research rooms specially equipped for the investigation of problems in industrial chemistry.

THE FOWLER SHOPS.

The equipment of the shops is selected with a view of its being the means of teaching modern methods of machine construction, rather than to develop individual skill. The order of progress of the student through the various departments is consistent with the same idea.

In producing castings for machines the first step of pattern making is provided for, in a room 50 by 80 feet on the second floor, by benches and bench tools of high class, sufficient for a class of eighteen in a single section; twelve Richardson 11″x 28″ speed-lathes with full tool equipment; a complete pattern maker's lathe, 18″ x 12′, and a 7-foot face-plate lathe; a combination table saw, an Oliver band saw, and a scroll saw; a power-driven boring machine and a sandpapering machine; and special hand tools to facilitate accurate and rapid work. The second step—that of the actual casting—is provided for by new foundry equipment installed in a room 60 by 66 feet, consisting of a Whiting melting cupola of one and one-half tons capacity per hour; a brass furnace complete; an automatic molding machine; a core machine and full equipment for core work; and all necessary hand tools for rapid and efficient work in a molding room, arranged in typical modern fashion. An elevator to the cupola-charging platform, and a geared tumbler and a grinder for cleaning castings, are included.

For preparing wrought metals, and for making cutting tools, the forge shop, 40 by 50 feet, is equipped with sixteen Sturtevant down-draft forges and one large forge for heavy work, with a full complement of smithing tools, a Little Giant power hammer to facilitate rapid work and to familiarize students with its use.

For the final work of machine construction, the machine shop, a room 50 by 80 feet (soon to be enlarged), is supplied with fourteen 14″ x 6′ Standard engine lathes; one 18″ x 12′ and one 14″ x 5′ Challenge engine lathes with full attachments; one Jones and Lawson 2″ x 24″ turret lathe with chucking attachments; one 26″ x 26″ x 7′ Gray planer; one Universal milling machine with spiral gear cutter and all attachments; a horizontal boring mill of late pattern; one 15″ crank shaper; one 25″ Challenge drill press with automatic feed; three 20″ drill presses; one sensitive drill press; one 1½″ bolt cutter; one Universal cutter and reamer grinder; one Yankee drill grinder; and other power dry and wet grinders, etc. The room has 160 feet of benches with twenty vises and a good outfit of hand tools, which, with stock and supplies, are kept in a tool room under the care of a skilled attendant, the students being held to a rigid observance of shop rules. Electric-motor drive by the group system is used throughout the shop.

THE POWER PLANT.

The new power plant is in the same building with the mechanical engineering laboratory, and is designed for the double purpose of furnishing light and power to the entire University and of giving engineering students an opportunity to study the power costs with modern equipment.

The boiler-room equipment consists of two 150-horsepower Bonus-Kennicott water-tube boilers, and one 85-horsepower return tubular boiler, all equipped with Jones underfeed stokers; a Sturtevant economizer; and an induced-draft system with motor-driven fan. A pressure of 150 pounds is carried. All feed water is metered with a Worthington piston meter, and coal-weighing scales are provided.

In the generator room is a 150 K. W. 115-230 volt three-wire D. C. Western Electric generator, direct-connected to an 11 x 19 x 16 cross-compound Ball engine making 225 R. P. M.; a 100 K. W. 2300-volt, three-phase 60-cycle Curtis turbo-alternator built by the General Electric Company; a 75 K. W. motor-generator set A. C. and D. C., with synchronous motor, by means of which both forms of current may be delivered with one steam machine in operation; one 8 x 12 x 7 x 12 compound duplex Advance service pump for the general water supply of the University and one large high-pressure Underwriter's pump for fire protection.

All the main engines and pumps exhaust into one 1200 sq. ft. surface condenser equipped with both wet and dry vacuum pumps for high-vacuum service, and a centrifugal circulating pump. All pumps are motor driven. Crane pipe and fittings have been used throughout the plant.

The switchboard is of General Electric design, and is fully appointed, with complete outfit for recording and indicating meters. Six single-phase lighting circuits, one three-phase power circuit, and three three-wire D. C. power circuits supply the University buildings through an underground conduit system installed by the Standard Underground Cable Company.

DESCRIPTION OF COURSES IN SCHOOL OF ENGINEERING.

All courses that are given in the first half of any semester are indicated by (*a*); those occurring in the second half of any semester by (*b*). The statement of hours refers to the number of actual hours per week. The value of each course is given in credits, one credit being one hour per week of recitation or lecture carried for a semester. In general, two hours a week per semester in drawing, shop or laboratory work equals one credit.

Courses numbered below 50 belong to the Freshman and Sophomore years. Courses numbered 50 and above to 100 belong to the Junior and Senior years.

BOTANY.

Associate Professor BILLINGS.

50E.—WATER BACTERIOLOGY. For students in municipal and sanitary engineering. A brief general study of bacteria and their relations to every-day life, and of laboratory methods of cultivating and examining them. Particularly a more detailed study of the water-borne pathogenic forms, and of the bacteria concerned in sewage purification. First semester, six hours, Monday, Wednesday, and Friday, 8 to 10. Three credits. Associate Professor Billings.

For other courses in botany, see "The College."

CHEMISTRY.

Professor BAILEY.
Associate Professor CADY.
Assocate Professor BUSHONG.
Assistant Professor TEAGUE.
Assistant Professor ALLEN.
Miss HEDGER, Instructor.
Mr. YOUNG, Instructor.
Mr. BRODERSON, Instructor.
Mr. NASH, Instructor.
Mr. HOBBS, Assistant Instructor.
Mr. FRICHOT, Assistant Instructor.

2.—ADVANCED INORGANIC CHEMISTRY. Lectures, recitations, and laboratory work. Required in Engineering School, Sophomore. First semester, lectures three hours and laboratory two hours for all engineers except chemicals, who have four hours laboratory and a total of five credits, 8 to 10. Four credits. Associate Professor Cady and assistants.

3.—QUALITATIVE ANALYSIS. Recitations and laboratory work. Cady's Principles of Inorganic Chemistry and Bailey and Cady's Guide to the Study of Qualitative Analysis. Must be preceded by course 2. Required in the Engineering School, Sophomore. Second semester, recitations two hours and laboratory four hours for all engineers except chemicals, who have six hours laboratory and a total of five credits, 8 to 10. Four credits. Associate Professor Cady and assistants.

51.—INDUSTRIAL CHEMISTRY. Three hours, first semester, at 9. A technical study of the manufacture of acids, alkalies, explosives, glass, pottery, porcelain, mortars, cements, paper, alcohol, vinegar, leather, etc. Thorpe's Outline of Industrial Chemistry. Open to Juniors and Seniors who have taken course 1. Three credits. Professor Duncan.

54.—QUANTITATIVE ANALYSIS. Lectures and laboratory work. Must be preceded by course 3. Required of mining engineers. First semester, ten hours, 3:30 to 5:30. Five credits. Required of chemical engineers, twenty hours, 1:30 to 5:30. Ten credits. Assistant Professor Landrum and assistants. Also given second semester, ten hours, 8 to 10. Five credits. Assistant Professor Allen.

50E.—GAS ANALYSIS. A laboratory course in the quantitative determination of the common gases, analysis of gaseous mixtures, flue gases, natural gas, etc. Gill's Gas Analysis and Hempel's Gas Analysis. Must be preceded by course 54. First semester, two hours, by appointment. One credit. Assistant Professor Allen.

51E.—OIL ANALYSIS. A laboratory course in the analysis of animal, vegetable or mineral oils. Determination of the specific gravity, viscosity, and other constants. Distillation as applied to mineral oils. Must be preceded by course 54. Second semester three hours, by appointment. Three credits. Associate Professor Bushong.

52E.—ELECTROLYTIC ESTIMATION OF METALS. A laboratory course in the practical work of analysis by electrolysis, including the use of the rotating cathode. Must be preceded by course 54. Second semester, two hours, by appointment. Two credits. Associate Professor Cady.

53E.—ANALYSIS OF BOILER FEED WATERS. Optional for engineers. Must be preceded by course 54. First semester, two hours. Two credits. Professor Bailey.

59.—ORGANIC CHEMISTRY. A study of the hydrocarbons and their derivatives. Lectures, recitations, and laboratory work. Must be preceded by courses 1 and 2. Required of chemical engineers, Junior. First or second semester, ten hours, 1:30 to 3:30. Five credits. Associate Professor Bushong.

64.—PHYSICAL CHEMISTRY. A course paying special attention to electrochemistry. Lectures and laboratory work. Must be preceded by chemistry 54, or by chemistry 3 and physics 1E and 2E and mathematics 7. Required of electrical engineers; optional for mining engineers. First semester, five hours, at 10:15. Five credits. Associate Professor Cady.

65.—PHYSICAL CHEMISTRY. A general course in theoretical and physical chemistry. Lectures and laboratory work. Required of chemical engineers. Second semester, five hours, at 10:15. Five credits. Associate Professor Cady.

56.—WATER ANALYSIS. For students in municipal and sanitary engineering. A brief study of the methods of quantitative analysis, followed by laboratory practice in the sanitary analysis of water and sewage. Interpretation of the results of sanitary analysis. Second semester, six hours, by appointment. Three credits. Professor Bailey.

Other courses in chemistry are open as optionals to chemical engineers. See "The College."

CIVIL AND MUNICIPAL ENGINEERING.

Dean MARVIN.
Associate Professor HOAD.
Associate Professor H. A. RICE.
Associate Professor DALTON.
Assistant Professor NEWTON.
Assistant Professor GARDNER.
Mr. PARKER.

1.—TOPOGRAPHICAL DRAWING.—A study of and practice in the conventional methods of representing topography, coupled with the platting of the results of field practice in connection with surveying. Required of Sophomore civil and mining engineering students. Second semester, six hours, Monday and Wednesday, or Thursday and Friday, 1:30 to 4:30. Three credits. Mr. Parker.

2.—SURVEYING. Engineer's instruments, their construction and adjustment. Methods of making and platting land, topographic, mining and hydrographic surveys. Sources of error and the means of controlling the precision of field work. Leveling and earthwork. Required of civil and mining engineering students. Sophomore, second semester, four hours, at 10:15, or 11:15, with field practice once a week. Five credits. Associate Professor Dalton, Assistant Professor Newton, and Mr. Parker.

3 or 53.—SUMMER FIELD WORK. Courses in practical surveying. The character of the work done will vary somewhat from year to year, depending upon the make-up of the body of students that go into camp. Ten hours per day for four weeks, at the close of the college year, in June. Associate Professor Dalton and assistants.

4.—STEREOTOMY. Required of civil engineering students. Sophomore, first semester, six hours, Monday and Wednesday, or Thursday and Friday, 1:30 to 4:30. Three credits. Mr. Parker.

50.—RAILWAY DRAWING. Railway plats, profiles and plans for track and small structures. Lectures and drawing-room practice in tracing and blue-printing and in platting the results of field work. Required of civil engineering students. Junior, first semester, six hours, Tuesday and Friday, 1:30 to 4:30. Three credits. Associate Professor Dalton.

51.—GRAPHICAL STATICS. The properties of equilibrium polygons and other methods of representing the actions of forces, with application to the determination of stresses in beams, roof-trusses, and stone arches. Lectures and drawing. Required of civil engineering students. Junior, second semester, six hours, Tuesday and Friday, 1:30 to 4:30. Three credits. Assistant Professor Gardner.

52.—CONTRACTS AND SPECIFICATIONS. An elementary course in the law of contracts, with special reference to engineering practice. The technical features of specifications. Methods of procedure in letting and conducting contract work, and the engineer's relation thereto. Required of all engineering students. Senior, second semester, (*b*), five hours, at 11:15. Two and one-half credits. Dean Marvin.

54.—HYDRAULIC CEMENT. A laboratory course in testing hydraulic cements and making comparison of their qualities. Reading, experimental work, and reports of tests made. Required of civil engineering students. Senior, second semester, four hours, Monday and Wednesday, 3:30 to 5:30. Two credits. Assistant Professor Gardner.

55.—MASONRY. Character of materials composing masonry. Methods of cutting and dressing stone. Foundations: Cribwork, cofferdams, caissons, piles and pile driving, concrete, pneumatic processes, etc. Required of civil engineering students. Senior, first semester, (*a*), five hours, at 8. Two and one-half credits. Assistant Professor Gardner.

56.—ROADS AND PAVEMENTS. A study of the materials for and methods used in the construction and improvement of country roads and city pavements. Earthwork, drainage, the road foundation, the wearing surface, etc. The economic importance of the "good-roads movement." Required of civil engineering students. Junior, second semester, two hours, at 9. Two credits. Associate Professor Dalton.

57.—RAILWAY LOCATION. The principles involved in an economic location and construction of railways. Analysis of traffic and operating expenses. The influence of proposed changes in location upon the amount of total revenue from traffic, the bonded debt and the corresponding fixed charges for interest, the operating expense, and the dividend-paying capacity of the road. Second semester, three hours, at 9. Three credits. Associate Professor Dalton.

58.—RAILWAY SURVEYING. A study of the methods of laying out and constructing railways. The setting out of simple and compound curves and calculation of excavation and embankments. Yards, turnouts, and switches. Easement curves of various types. Calculation of waterways, and methods of staking out foundations for culverts and bridges. This course must be preceded by a general course in surveying. Required of civil engineering students. Junior, first semester, four hours, at 10:15 or 11:15, with field practice one-half day per week. Five credits. Associate Professor Dalton.

59.—SEWERAGE. An elementary course in the collection, removal and disposal of city sewage. Separate and combined systems. Methods of flushing and ventilating sewers. Principles of the design and construction of sewers and storm drains; of manholes, flushing devices, inlets, catch basins, inverted siphons, and other sewer appurtenances. Brief study of the purification of sewage by the standard processes. Two and one-half credit hours. First semester, (*a*), at 11:15. Two and one-half credits. Assistant Professor Gardner.

60.—WATER SUPPLY. An elementary course in the collection, purification and distribution of municipal water supplies. Requisites of a supply as to quality and quantity. Relation of water supply to public health. Sanitary surveys of sources of supply. Collection of water from rivers, lakes, deep and shallow wells, and the design and construction of impounding reservoirs. Distribution systems; materials and design; fire protection; standpipes and elevated tanks. Brief study of the design and construction of settling basins, rapid and slow sand filters, and other acceptable devices for the purification of water. Waterworks maintenance and operation; cleansing of water pipes; destruction of algæ in reservoirs. Five hours, first semester, (*b*), at 11:15. Two and one-half credits. Assistant Professor Gardner.

61.—ROOFS AND BRIDGES. Analytical and graphical calculation of stresses in framed structures under various forms of loading. This course must be preceded by course 51 in mechanics. Required of civil engineering students. Senior, first semester, ten hours, 1:30 to 3:30. Five credits. Associate Professor H. A. Rice.

62.—BRIDGE DESIGNING. A study in bridge details and the dimensions of parts. Students work out designs for a plate girder and a simple truss. Must be preceded by course 61. Required of civil engineering students. Senior, second semester, ten hours, 1:30 to 3:30. Five credits. Associate Professor H. A. Rice.

63.—ENGINEERING MATERIALS. A study of the methods of manufacture of structural materials and the different means and machines used in their testing. Opportunity will be given for specialization along some particular line, if desired, and considerable experimental work may be done in the laboratory. Recitations, lectures, library and laboratory work. Optional for Seniors. Five hours, second semester, by appointment. Five credits. Assistant Professor Corp.

64.—SANITARY ENGINEERING DESIGN. An advanced course, to follow courses 59 and 60. A more detailed study of the principles of good design of engineering works for sewerage and drainage; for the purification of public water supplies; and for the treatment of city sewage and of industrial wastes. Lectures, recitations and library reading; drawing-board designs of typical constructions; visits to sanitary engineering works. Senior, five hours, second semester, at 8. Five credits. Associate Professor Hoad.

65.—REINFORCED CONCRETE. A course of study in the modern theory and practice of the design of beams, floor slabs, columns, retaining walls, conduits, arches, and other forms of reinforced concrete construction. Mathematical theory, study of plans, and design of typical structures. Second semester, (*b*), five hours, at 9. Two and one-half credits. Assistant Professor Gardner.

66.—MAINTENANCE OF WAY. An advanced course in railway engineering. Optional for Seniors. Second semester, five hours, at 8. Five credits. Associate Professor Dalton.

67.—MUNICIPAL ENGINEERING DRAWING. A drawing-room course dealing with city maps and plats, street profiles and cross-sections, sewerage and drainage maps, standard plans for street pavements, street intersections, catch basins, storm-water drains, concrete bridges, and other work commonly found in a city engineer's office. First semester, six hours, Monday and Wednesday, 1:30 to 4:30. Three credits. Assistant Professor Gardner.

68.—STREET CLEANING AND GARBAGE COLLECTION AND DISPOSAL. A series of lectures extending through the term. A detailed study of methods and costs of cleaning the various forms of street surfaces. A study of modern methods of collecting and disposing of garbage, with reference to the sanitary principles involved as well as the financial aspects of the problem. Second semester, Monday, at 3:30. One credit. Associate Professor Hoad.

69.—SANITARY SCIENCE AND PUBLIC HEALTH PROBLEMS. It is the object of this course to present a broad and general view of the large body of sanitary science upon which the modern practice of sanitation is based. The effects of good practice in such matters as public water supply, sewerage and drainage, state and federal control over the pollution of streams, the elimination of dust and mud and snow from city streets, and the ventilation of public buildings, are studied. First semester, (*a*), five hours, at 11:15. Two and one-half credits. Associate Professor Hoad.

70.—SANITARY ENGINEERING LABORATORY. A laboratory course to be pursued in connection with experiment station work in water or sewage purification. This course is especially designed to acquaint the student with quick approximate methods of testing sewage effluents and of securing information relative to the controlling characteristics of water supplies. First semester, two hours, Tuesday, 3:30 to 5:30. One credit. Assistant Professor Gardner.

71.—SURVEYING. A briefer course than number 5, primarily for Senior electrical engineering students. First semester, three hours, at 11:15. Three credits. Mr. Parker.

72.—SANITARY INSPECTION AND REPORTS. Visits to neighboring engineering works of sanitary interest, particularly waterworks and water and sewage purification plants, and to various municipal works in process of construction. By appointment. Associate Professor Hoad.

For other courses in civil engineering, see "The College."

ELECTRICAL ENGINEERING.

Professor SHAAD.
Mr. JOHNSON.
Mr. ———.

Courses 50 to 52, and 54 to 58, inclusive, and 60 and 61 are required of all electrical engineering students. Courses 50, 51, 54, 55, and 63, are required of mechanical engineering students. Courses 59 and 62 are optional for electrical engineering students.

50.—DYNAMO MACHINERY. Theory of direct-current generators and motors. Prerequisites, physics 1E and 2E. Junior, first semester, three hours, at 10:15. Three credits. Mr. Johnson.

51.—THEORY OF ALTERNATING CURRENTS. A mathematical treatment of alternating-current phenomena and the theory of alternating-current machinery. Fundamental types. Prerequisite, course 52. Junior, second semester, five hours, at 11:15. Five credits. Professor Shaad.

52.—DYNAMO MACHINERY. Advanced theory of alternating-current machinery. Senior, first semester, five hours, daily, at 8. Five credits. Professor Shaad.

54.—ELECTRICAL LABORATORY. An experimental course for the purpose of illustrating the principles of direct-current dynamo machinery and acquainting the student with the types and performance of direct-current apparatus. Course 50 required, or to be taken simultaneously. Junior, first semester, four hours, two days per week on alternate weeks, 1:30 to 5:30. Two credits. Mr. Johnson.

55.—ELECTRICAL LABORATORY. A continuation of course 54. Course 51 required, or to be taken simultaneously. More advanced work with direct-current machinery is given and experiments with alternating-current apparatus are introduced. Some time is devoted to the calibration of electrical instruments. Junior, second semester, four hours, two days per week on alternate weeks, 1:30 to 5:30. Two credits. Mr. Johnson.

56.—ELECTRICAL LABORATORY. Advanced experiments with electrical machinery and the testing of machines, chiefly of alternating-current types. Senior, first semester, three hours, two days per week, 1:30 to 4:30. Three credits. Course 52 to be taken simultaneously. Professor Shaad.

57.—ELECTRIC LIGHTING. A course in illumination and photometry in which the available light sources are studied, and the methods of application to artificial illumination of streets and buildings are discussed. Laboratory and field work in the measurement of light sources and illumination is given. Senior, second semester, (*a*), five hours, at 11:15. Two and one-half credits. Mr. Johnson.

58.—ELECTRIC POWER TRANSMISSION. A series of lectures and recitations devoted to the study of the principles involved and the methods used in the design of transmission and distributing systems. Course 52 required. Senior, second semester, (*a*), five hours, at 9. Two and one-half credits. Professor Shaad.

59.—ELEMENTARY TELEPHONY. Lectures, recitations, and laboratory work. This course develops the principles that underlie all telephone apparatus and gives practical experiments with the fundamental telephone transmitters, receivers and central-station arrangements. Junior or Senior optional, second semester, five hours, by appointment. Five credits. Mr. ———.

60.—ELECTRIC RAILWAYS. The theory and practice of the design, construction and operation of electric railway systems. Course 58 required. Senior, second semester, (*b*), five hours, at 9. Two and one-half credits. Professor Shaad.

61.—PROFESSIONAL THESIS. Senior, first semester, two hours, and second semester, six hours, by appointment. Professor Shaad, or other instructors, according to the line of work chosen.

62.—ELECTRICAL ENGINEERING PRACTICE. This course consists in the discussion of practical engineering problems as presented to the professional engineer and the determination of the most suitable electrical machinery to be selected for the work to be done. The course is complementary to mechanical engineering 59. Senior optional, second semester, three hours, at 10:15. Three credits. Mr. Johnson.

63.—ALTERNATE CURRENT MACHINERY. A special course for mechanical engineering Seniors, and supplemental to course 51. Two hours, first semester, at 11. Two credits. Professor Shaad.

ENGLISH LANGUAGE AND LITERATURE.

Assistant Professor RAYMOND.
Assistant Professor GARDNER.
Mr. SCHULTZ.
Mr. STELTER.

The instruction in this department, while parallel to that in the College, and having the same general aim, is designed especially to accord with the other work of the engineering students. The three courses here numbered are required before graduation; for students who wish to spend more time in this kind of work the research class is provided, and the appropriate classes in the College are open.

1E.—RHETORIC. Written exercises and papers, with study of language usage. Required of all Freshmen. First semester, three hours, at 8, 9, 10:15, 11:15, 3:30, and 4:30. Three credits. Assistant Professor Raymond, Assistant Professor Gardner, Mr. Schultz, and Mr. Stelter.

2E.—RHETORIC. Continuation of course 1. Second semester, two hours, at 8, 9, 10:15, 11:15, 3:30, and 4:30. Two credits. Assistant Professor Raymond, Assistant Professor Gardner, Mr. Schultz, and Mr. Stelter.

50E.—ADVANCED COMPOSITION. Practice in the gathering and analyzing of material, and in the presentation of information and opinion in scientific papers, and study of the methods used in these and other papers. Required of all students, one term in Junior and Senior year, three hours: first semester, at 8; second semester, at 9. Three credits. Assistant Professor Raymond.

INDEXING AND RESEARCH IN THE LITERATURE OF ENGINEERING SCIENCE. Informal class, with headquarters in the office of this department, meeting once a week for conference, and working in the material of the engineering library.

The department of English is provided with references, illustrative matter and other helps for reading in general and in engineering literature, and in the preparation of special papers.

GEOLOGY.

Professor HAWORTH.
Assistant Professor TODD.
Assistant Professor TWENHOFEL.

1.—ELEMENTARY GEOLOGY. A study of the elementary principles of geology, including a general outline of geologic principles and geologic agencies. An acquaintance with the elements of chemistry, zoölogy and botany will be of advantage in this course. Required of Junior civil and Sophomore mining engineers. First semester, five hours, at 9, 10:15, 11:15, or 2:30; second semester, at 8, 9, 10:15, or 11:15. Five credits. Professor Haworth, Assistant Professor Todd, and Assistant Professor Twenhofel.

52.—ECONOMIC GEOLOGY I. A general study of the metallic and nonmetallic products of the mine and quarry, considered from a scientific and a practical standpoint, including the nature, origin, amount and geographic and geologic distribution of the same. Must be preceded by elementary chemistry and course 1, or mineralogy 1E. Required of Junior mining engineers. First semester, lectures and library work, three hours, Monday, Wednesday, and Friday, at 9. Three credits. Professor Haworth.

53.—ECONOMIC GEOLOGY II. A continuation of course 52. Nonmetallic products. Second semester, two hours, Tuesday and Thursday, at 10:15. Two credits. Professor Haworth.

Other courses in geology are open as optionals to engineering students. For details, see the courses in "The College."

GERMAN.

Associate Professor ENGEL.
Assistant Professor BRIGGS.

1.—OUTLINE OF GRAMMAR. The first twenty-two lessons of Carruth's Otis's Grammar, with composition exercises; Carruth's Reader, about fifty pages. First semester, five hours, at 9. Five credits. Associate Professor Engel and Assistant Professor Briggs.

2.—READER AND GRAMMAR. The last eight lessons of Carruth's Otis's Grammar; Carruth's Reader completed; Hoyse's Die Blinden as a basis for narrative and conversation, and Schiller's Wilhelm Tell. Second semester, five hours, at 1:30. Five credits. Assistant Professor Briggs.

3.—GERMAN PROSE. Lessing's Minna von Barnhelm; extracts from Schiller's Der dreiszigjährige Krieg, preceded by a review of grammar. First semester, five hours, at 8. Five credits. Associate Professor Engel and Assistant Professor Briggs.

4.—SCHILLER'S WALLENSTEIN; SCIENTIFIC PROSE. Second semester, five hours, at 10:15. Five credits. Associate Professor Engel.

MATHEMATICS.

Professor YOUNG.
Associate Professor VAN DER VRIES.
Assistant Professor PITCHER.
Assistant Professor WHITE.
Mr. FRIZELL, Instructor.
Mr. HESS, Instructor.

2.—COLLEGE ALGEBRA. Rapid review of elementary algebra; graphic representation; logarithms; determinants; theory of equations; Horner's method of approximation. Required of all Freshmen in the School of Engineering. Ashton's College Algebra, or Rietz and Crathorne's College Algebra. Both semesters—first semester, three hours, at 8, 9, 10:15, 11:15, 2:30, or 3:30; second semester, three hours, at 2:30 or 3:30. Three credits. Assistant Professor Pitcher, Mr. Frizell, and Mr. Hess.

3.—PLANE TRIGONOMETRY. The six trigonometric functions; principal formulas of plane trigonometry; solution of triangles and practical problems. Required of all Freshmen in the School of Engineering. Ashton's Trigonometry. Both semesters—first semester, two hours, at 8, 9, 10:15, 11:15, 2:30, or 3:30; second semester, two hours, at 1:30 or 3:30. Two credits. Assistant Professor Pitcher, Mr. Frizell, and Mr. Hess.

4.—ANALYTICAL GEOMETRY I. The straight line and circle; loci problems. Required of all Freshmen in the School of Engineering. Ashton's Analytical Geometry. Both semesters—first semester, two hours, at 9 or 10:15; second semester, two hours, at 8, 9, 10:15, 11:15, or 2:30. Two credits. Associate Professor Van der Vries, Assistant Professor Pitcher, Assistant Professor White, Mr. Frizell, and Mr. Hess.

5.—CALCULUS I. Differential calculus; fundamental principles; derivatives; applications to geometry and mechanics; maxima and minima; indeterminates; series. Required of all Freshmen in the School of Engineering. Granville's Calculus. Both semesters—first semester, three hours, at 9 or 10:15; second semester, three hours, at 8, 9, 10:15, 11:15, or 2:30. Three credits. Associate Professor Van der Vries, Assistant Professor Pitcher, Assistant Professor White, Mr. Frizell, and Mr. Hess.

6.—ANALYTICAL GEOMETRY II. Conic sections; higher plane curves; solid analytics. Required of all Sophomores in the School of Engineering. Ashton's Analytical Geometry. Both semesters—first semester, two hours, at 9, 10:15, or 11:15; second semester, two hours, at 9 or 10:15. Two credits. Associate Professor Van der Vries, Assistant Professor Pitcher, and Mr. Frizell.

7.—CALCULUS II. Integral calculus; integration; definite integrals; applications to lengths, areas, and volumes. Required of all Sophomores in the School of Engineering. Granville's Calculus. Both semesters—first semester, three hours, at 10:15, or 11:15; second semester, three hours, at 9 or 10:15. Three credits. Associate Professor Van der Vries, Assistant Professor Pitcher, and Mr. Frizell.

9E.—CALCULUS III. Application of calculus to problems in solid geometry; centers of gravity; moments of inertia; differential equations. Required of all Sophomores in the electrical and mechanical engineering courses. Granville's Calculus. Both semesters—first semester, two hours, at 9; second semester, two hours, at 10:15 and 11:15. Two credits. Associate Professor Van der Vries and Assistant Professor Pitcher.

For other courses in mathematics, see "The College."

MECHANICS.

Associate Professor H. A. RICE.
Assistant Professor HOOD.
Assistant Professor CORP.
Assistant Professor COCHRAN.
Assistant Professor NEWTON.
Mr. PARKER.
Mr. WHITE.

1.—ELEMENTARY MECHANICS. An elementary course, requiring some knowledge of elementary physics and trigonometry. Freshman, first semester, two hours, Tuesday and Thursday, at 8, 9, 10:15, 11:15, 3:30, or 4:30. Two credits. Assistant Professors Hood, Cochran, and Newton, and Mr. Parker.

50.—MECHANICS. A study of the laws of statics and dynamics. Action of forces upon bodies and the resulting motions. Required of all engineering students. Senior for mining engineers, Junior for all others. First semester, five hours, at 8 or 9. Five credits. Associate Professor H. A. Rice and Assistant Professor Newton.

51.—STRENGTH OF MATERIALS. The theory of resistance to stress and application to engineering construction. Required of all engineering students. Senior for mining engineers, Junior for all others. Second semester, four hours, at 8 or 10:15. Four credits. Associate Professor H. A. Rice, and Assistant Professor Newton.

52.—TESTING OF MATERIALS. A laboratory course to accompany course 2. The testing of iron, steel, wood and other materials of construction for resistance to tension, compression, torsion, bending, and shearing. Experimental determination of the limits of safe loading. The testing of paving brick. For all engineering students. Senior for mining engineers, Junior for all others. Second semester, four hours, Monday, Wednesday, Thursday, or Friday afternoon, or Saturday morning. Two credits. Assistant Professor Corp, and Mr. White.

53.—HYDRAULICS. A study of the laws governing the pressure and flow of liquids and gases and the force of and resistance to their motion. Required of civil and mechanical and optional for mining engineering students. Senior, first semester, (*a*), four hours, at 10:15. Two credits. Assistant Professor Corp, and Mr. White.

54.—HYDRAULIC LABORATORY. A course to accompany course 53 and the course in hydraulic machinery. Experimental work with the flow of water over weirs, through orifices and pipes, and in testing hydraulic machinery. Required of civil and mechanical engineering students. Senior, first semester, two hours, Monday, Wednesday, or Friday, 3:30 to 5:30. One credit. Assistant Professor Corp, and Mr. White.

MECHANICAL DRAWING.

Assistant Professor HOOD.
Assistant Professor NEWTON.
Assistant Professor COCHRAN.

1.—FREE-HAND DRAWING. Engineering lettering in pencil and in ink. Free-hand working sketches of simple machine parts. Required of all engineering students. Freshmen, first six weeks of first semester, six divisions; Monday, Wednesday and Friday, 8 to 10, 10:15 to 12:15, 1:30 to 3:30, 3:30 to 5:30, Tuesday and Thursday from 1:30 to 3:30 and Saturday 8 to 10, or Tuesday and Thursday from 3:30 to 5:30 and Saturday 10 to 12, six hours. One credit. Assistant Professors Hood, Cochran, and Newton.

2.—ELEMENTARY MECHANICAL DRAWING. Revolution of geometrical solids. Working drawings of simple machine parts. Penciling, tracing, and blue-printing. Detailing machine parts from assembly drawings. Each student uses his drawings as made in this course in the pattern and machine shops. Required of all engineering students. Freshman, last fourteen weeks of first semester, same hours as in course 1, six hours. Two credits. Assistant Professors Hood, Cochran, and Newton.

3.—DESCRIPTIVE GEOMETRY. Principles of projection. Execution of a number of original exercises. Required of all engineering students. Freshman, second semester, three hours, at 8, 9, 10:15, 11:15, 2:30, or 3:30. Three credits. Assistant Professors Hood, Cochran, and Newton.

4.—MACHINE DRAWING. Sketching of machine parts and preparation of working drawings; detailing of machines from sketches, notes, assembly drawing and assembled machines; tracing and blue-printing; notes and lectures on drafting-room methods. Each student prepares complete drawings for some simple machine. Required of all engineering students. Freshman, second semester, same hours as in course 1, six hours. Three credits. Assistant Professors Hood, Cochran, and Newton.

MECHANICAL ENGINEERING.

Professor WALKER.
Assistant Professor CORP.
Assistant Professor SLUSS.
Mr. WHITE.
Mr. SNEETHERS.

1.—MACHINE DRAWING. Making of working drawings from sketches of assembled parts, followed by an assembly drawing from detailed working drawings. Required for mechanical, electrical, mining and chemical engineers. Sophomore, first semester, analytical and graphical solution of problems in the design of machine parts, transmission and hoisting devices. For mechanical engineers. Text, Elements of Machine Design, by Kimball and Barr. Monday and Wednesday or Thursday, 1:30 to 4:30, and Saturday, 9 to 12, six hours. Three credits. Assistant Professor Sluss.

2.—KINEMATICS. A study of the motion of machine parts and of methods of transmission of motion by gears, belts, cams, etc. Recitations and drawing for mechanical and electrical students. six hours. Text, Dunkerley's Mechanism. Sophomore, second semester, Monday and Wednesday, or Tuesday and Thursday, 1:30 to 4:30. Three credits. Assistant Professor Sluss.

50.—STEAM-ENGINE DESIGN. Valve-gear designing; the design of a shaft inertia governor; analysis of forces due to steam pressure; crank-effort diagrams and fly-wheel design. Text, Halsey's Valve Gears. Senior, first semester, four hours, Tuesday, 1:30 to 5:30. Two credits. Assistant Professor Sluss.

51.—MACHINE DESIGN. A course covering the generally accepted methods of designing machine parts, power transmission systems, hoisting apparatus, etc. The time is divided between the classroom and the drafting room. Text, Benjamin's Machine Design and Kent's Handbook. Junior, second semester, three hours, Monday and Wednesday, at 9, and Friday, 1:30 to 3:30. Three credits. Assistant Professor Sluss.

52.—DESIGNING. An advanced course devoted to special selected problems from the following: Steam turbines, compound steam engines, gas engines, steel-mill building construction, traveling cranes, refrigerating plant, central heating systems. Senior, second semester, ten hours, Monday, Tuesday, and Thursday, 1:30 to 5. Five credits. Professor Walker.

3.—STEAM MACHINERY. (*a*) Fuels, combustion, and steam generation. (*b*) A study of boiler and engine types, and engine mechanism. Principal text, Kent's Steam Boiler Economy. Sophomore, second semester, two hours, Monday and Wednesday, at 10:15 or 11:15. Two credits. Assistant Professor Sluss.

53.—ENGINES AND BOILERS. A brief study of the general problem of steam-power generation from the standpoint of the installing engineer. Text, Heat Engines, by Allen and Bursley. Required of civil engineering students. Junior, second semester, Tuesday, Thursday, and Friday, at 11:15, and five exercises in the steam laboratory on Saturday, 8 to 12. Four credits. Professor Walker and Mr. Bohnstengel.

54.—HEATING AND VENTILATION. Laws of heat transfer; amount of air required for ventilation; methods and apparatus employed in modern buildings; central heating plants. Senior, second semester, two hours, at 9. Two credits. Professor Walker.

55.—GAS-ENGINE DESIGN. Power, efficiency and economy of the gas engine; study of the forces produced by gas pressure and inertia; structural design. Text, Lucke's Gas-engine Design. Senior, first semester, (*b*), four hours, Wednesday, 1:30 to 5:30. Two credits. Professor Walker.

56.—HYDRAULIC MACHINERY. A study of types of pumping machinery, with special reference to city water supply, sewerage and irrigation plants. The questions of first cost and maintenance of plant and economy in operation are fully discussed. Also, a study of water-power development. Lectures, assigned reading, and reports. Senior, first semester, (*b*), four hours, at 10:15. Two credits. Assistant Professor Corp and Mr. White.

57.—THERMODYNAMICS. A study of the relations between heat and mechanical energy; theory of heat engines. Must be preceded by physics 1E and 2E and calculus. For Senior mechanical engineering students the text is Peabody's Thermodynamics. First semester, (*a*), five hours, at 9. For electrical engineering students the course will include a study of the actual steam engine. Texts, Benjamin's Steam Engine and Moyer's Steam Turbines. First semester, four hours, at 11:15. Four credits. Professor Walker.

58.—ADVANCED STEAM ENGINEERING. Study of heat losses in the steam engine; compounding; superheating; jacketing; the steam jet; design of the steam turbine. Texts, Moyer's Steam Turbines and Peabody's Thermodynamics. Senior, first semester, (*b*), five hours, at 9. Two and one-half credits. Professor Walker.

59.—ENGINEERING PRACTICE. Modern industrial plant organization, cost accounting and plant management; comparative study of power costs with different prime movers. Lectures, assigned reading and problems. Senior, second semester, two hours, Tuesday and Thursday, at 10:15. Two credits. Professor Walker.

60.—ENGINEERING LABORATORY. (*a*) Theory and use of planimeters; calibration of apparatus; cement testing; valve setting; (*b*) for Senior electricals, efficiency tests of steam boiler and engine, injector, and gasoline engine, with complete thermal analysis. (*b*) For Junior mechanicals, flue gas analysis, proximate analysis of coal, coal calorimetry, and tests for physical properties of lubricating oils. First semester, four hours, Tuesday or Thursday, 1:30 to 5:30. Two credits. Assistant Professor Corp and Mr. Bohnstengel.

61.—ENGINEERING LABORATORY. Complete testing of lubricants; efficiency tests of steam boilers, steam engines (with Hirn's analysis), steam pumps, gas engines, air compressors, etc. Chart study of steam-plant efficiency. Special subjects for investigation are assigned, to test the student's capacity for original work. Senior, second semester, four hours, Wednesday, 1:30 to 5:30. Two credits. Professor Walker.

62.—MECHANICS OF THE STEAM ENGINE. Course outlined in course 50 is followed through for a particular engine, together with the design of the engine parts. Also, problems in the mechanical transmission of power. Required for electrical students. Text, "The Steam Engine," by Benjamin, and special notes. Junior, second semester, three hours, Monday, Wednesday and Friday, at 8. Three credits. Assistant Professor Sluss.

63.—THESIS WORK. Senior, first semester, Thursday, 1:30 to 3:30; second semester, Friday, 1:30 to 5:30. Three credits. Professor Walker.

64.—SUMMER VACATION WORK. Two months to be spent in regular work in some shop or manufacturing plant of good standing. A report on this work, with a certified statement from the shop foreman or the superintendent, must be presented before credit can be given.

For courses open to graduate students, see Graduate School.

METALLURGY.

Assistant Professor MCFARLAND.

57.—ASSAYING AND METALLURGICAL ANALYSIS. The fire assay of ores of gold, silver and lead, followed in the second half semester by the volumetric analysis of ores of copper, zinc, lead, manganese, etc., and by coal and flue gas analysis. Lodge's Notes on Assaying and Low's Technical Methods of Ore Analysis. Must be preceded by chemistry 54 and mineralogy 1E. Second semester, ten hours, 3:30 to 5:30, and by appointment. Five credits. Assistant Professor Teague and assistant.

61.—METALLURGY I. General metallurgy and metallurgy of iron and steel. Must be preceded by chemistry 3. Required of mechanical engineers, Junior, and chemical engineers, Senior; optional in the College, and for mining engineers, Senior. First semester, five hours, daily, at 11:15. Five credits. Assistant Professor Teague.

62.—METALLURGY II. Metallurgy of lead, zinc, and copper, followed by metallurgy of silver, gold, mercury, and tin. Study of principal ores and methods of extraction and refining, amalgamation, chlorination and cyanide processes, pyritic smelting, etc. Must be preceded by chemistry 3. Required of mining engineers, Senior. Optional in the College, and for chemical engineers, Senior. Second semester, five hours, daily, at 11:15. Five credits. Assistant Professor Teague.

63.—METALLURGICAL LABORATORY. This course includes pyrometric and calorimetric measurements, preparation of silicates and alloys, oxidation and reduction reactions, amalgamation, chlorination, cyaniding and leaching, etc. Open to Juniors, Seniors and graduate students who have taken or are taking metallurgy 61 or 62. Either semester, two hours, by appointment. Assistant Professor Teague.

MINERALOGY.

Professor HAWORTH.
Assistant Professor TODD.

1E.—ELEMENTARY MINERALOGY I. A brief course in crystallography, blowpipe analysis, and systematic mineralogy, consisting of lectures and laboratory work. Sophomore, second semester, five hours, 3:30 to 5:30. Five credits. Assistant Professor Todd.

Other courses in mineralogy are open to engineering students as optionals. For these, see "The College" list of courses.

MINING ENGINEERING.

Professor HAWORTH.
Associate Professor YOUNG.

50.—MINING. Underground surveying, to be supplemented by field work. Excavation for mining purposes, quarrying, boring for gas, oil and water. Manufacture and use of explosives. Sinking of shafts, tunneling, support of underground excavations. Lectures and recitations. Required of students of mining engineering. Junior, first semester, five hours, at 8. Five credits. Associate Professor Young.

51.—ORE DRESSING. A study of all methods used for the separation and concentration of valuable minerals. Recitations, lectures, and laboratory work. Richard's Text Book of Ore

Dressing. Required of students of mining engineering. Junior, first semester, two hours, at 9, two credits; second semester, three hours, at 10:15, three credits. Associate Professor Young.

52.—POWER, EXTRACTION, DRAINAGE, VENTILATION. Steam, compressed air and electricity as applied to mining; mining hydraulics and the drainage of mines. Handling of ore underground and on the surface. Ventilation. Mine accidents. Required of students of mining engineering. Senior, first semester, five hours, at 10:15. Five credits. Associate Professor Young.

53.—SAMPLING AND EXPLOITATION. The best methods of sampling, developing and working mineral deposits, including studies of important mining districts. Required of students of mining engineering. Senior, second semester, (*a*), five hours, at 11:15. Two and one-half credits. Associate Professor Young.

54.—MINE PLANT. A study of the equipment necessary for the exploitation of mineral deposits and of important examples; building materials, foundations, mine buildings; the design of mine plants. Optional for students of mining engineering. Senior, second semester, five hours, at 9. Five credits. Associate Professor Young.

55.—MINE ADMINISTRATION. Mine accounts and management; care of sick and injured in case of accident; rules and regulations for equipping expeditions and maintaining camps. Optional for mining engineering students. Senior, first semester, (*a*), five hours, by appointment. Two and one-half credits. Associate Professor Young.

56.—COAL MINING. Methods of working coal beds and of handling coal. Properties of mine gases; safety lamp; explosives; ventilation; cause and prevention of explosions. May be substituted for mining 52. Open to students not enrolled in the course in mining engineering. Second semester, five hours, at 9. Five credits. Associate Professor Young.

57.—MINING LAW. A course outlining the laws relating to the mining industries. Recitations and lectures. Second semester, one hour, in alternate years. (Given in 1911.) Associate Professor Humble.

58.—PROFESSIONAL THESIS. This may be an elaborate description of a mining or metallurgical plant or of a mining district, or may be founded upon research work done at the University.

59.—SUMMER WORK. Each candidate for a degree is required to give evidence of having had experience in some phase of mining work. This may be gained by an investigation of some mining district under the direction of an instructor, or by obtaining employment in mining work.

PHYSICS.

Professor KESTER.
Associate Professor M. E. RICE.
Assistant Professor STIMPSON.
Mr. SMITH.

1E.—GENERAL PHYSICS. A fundamental course of experimental lectures, recitations and problems. Prerequisites, plane trigonometry and some knowledge of analytical geometry and calculus. Sophomore, first semester, five hours, Monday, Tuesday, Wednesday, and Thursday, at 10:15 or 11:15, and two hours of laboratory per week. Five credits. Professor Kester, Associate Professor M. E. Rice, Assistant Professor Stimpson, and Mr. Smith.

2E.—GENERAL PHYSICS. A continuation of course 3. Sophomore, second semester, five hours, Monday, Tuesday, Wednesday, and Thursday, at 10:15 or 11:15, and two hours of laboratory per week. Five credits. Professor Kester, Associate Professor M. E. Rice, Assistant Professor Stimpson, and Mr. Smith.

52.—THEORY OF ELECTRICITY AND MAGNETISM. First semester, three hours, at 9. Three credits. Associate Professor M. E. Rice.

60E.—ELECTRICAL MEASUREMENTS I. A laboratory course coordinate with 52. First semester, four hours per week, by appointment. Two credits. Associate Professor M. E. Rice.

61E.—ELECTRICAL MEASUREMENTS II. Continuation of course 60E. Second semester, four hours, by appointment. Two credits. Associate Professor M. E. Rice.

For electrical courses in physics, see "The College" and "The Graduate School."

ROMANCE LANGUAGES.

Professor GALLOO.
Associate Professor BASSETT.
Miss GARDNER.

French.

1.—ELEMENTARY FRENCH I. Grammar (Fraser and Squair) and easy reading. Drill in pronunciation, accidence and easy syntax. Open to students who have had three years of Latin or German. First semester, five hours, at 1:30. Five credits. Miss Gardner.

Students who have had only two years of Latin or German form a section, meeting at 8.

2.—ELEMENTARY FRENCH II. A continuation of course 1. Reading of simple prose texts, with exercises in dictation and elementary composition. Second semester, five hours, at 1:30. Five credits. Miss Gardner.

For advanced courses in French, see "The College."

Spanish.

1.—ELEMENTARY SPANISH I. An outline of grammar (Hills and Ford). Reading of short stories. Elementary composition. Open to students who have had three years of Latin, French or German. First semester, five hours, at 9, 11:15, or 1:30. Also second semester, five hours, at 2:30. Five credits. Associate Professor Bassett and Miss Gardner.

Students who have had only two years of Latin, French or German form a section, reciting during the fall term at 1:30.

2.—ELEMENTARY SPANISH II. Grammar and composition. Reading of easy modern prose: Carrión-Aza, Pérez, Galdós, Palacio Valdés, etc. Second semester, five hours, at 9, 11:15, or 1:30. Five credits. Associate Professor Bassett and Miss Gardner.

For advanced courses in Spanish, see "The College".

SHOP WORK.

Assistant Professor WARD.
Assistant Professor JONES.
Mr. BERKELEY.
Mr. LANDRUM.

SHOP 1.—FORGING. The regular beginning course for students in engineering, consisting of working wrought iron, mild steel, and tool steel; pointing, heading, welding, etc.; making tool-steel tools, such as punches, cold chisels, lathe tools, and pliers. Short lectures are given when necessary on such subjects as smithing coal, the making of wrought iron and how to work it; also methods of working mild steel and tool steel. Five hours a week. Two and one-half credits. Mr. Berkeley.

SHOP 2.—PATTERN MAKING. This course consists of: (*a*) Descriptive lectures and demonstrations on the properties of wood; selection and comparative values of different woods; practical construction of patterns to prevent distortion by shrinkage or warping; the relation of the pattern to foundry practice; the allowance for draft, shrinkage, and finish; the use of cores and making of core boxes, etc. (*b*) The theory and practice of the use of hand tools used in pattern construction. (*c*) A comprehensive course of exercises in wood turning. (*d*) The making of two or more patterns of representative types, embracing all the essential features peculiar to pattern work, together with the necessary core boxes, prints, and appurtenances. Students applying for advanced standing in shop 2 or credit for manual training in high school will be required to take section (*a*) of this course and an examination on same. Five hours a week. Two and one-half credits. Assistant Professor Jones and Mr. Landrum.

SHOP 3.—BENCH WORK. Exercise in filing, key fitting, drilling holes, riveting, chipping, and scraping to a true surface. Also, making calipers and side cutting pliers. This work brings in use the steel hand tools and pliers made in shop 1. Also the use of machine tools in drilling, grinding, and polishing. Foundry practice will be substituted for a part of this course. Five hours a week. Two and one-half credits. Assistant Professor Ward.

SHOP 4.—LATHE WORK. The use and testing of the tools which have been made in shop 1, centering work, turning on centers to fit standard gauges, turning tapers and curved surfaces, turning shafting, cutting threads, making small cap screws and set screws. Assistant Professor Ward.

SHOP 50.—LATHE AND MACHINE TOOL WORK. Making close fits with ordinary inside and outside calipers; cutting special screws and threads inside; machining, boring and reaming the cast-iron parts of machinery under construction, from blue prints and sketches. Five hours a week. Two and one-half credits. Assistant Professor Ward.

SHOP 51.—HEAVY LATHE WORK, PLANER AND MILLING-MACHINE WORK. Tool and jig making; grinding hardened work; making mandrels, reamers, taps, and special tools for the general shop use. Required only of mechanical engineering students. Five hours a week. Two and one-half credits. Assistant Professor Ward.

All materials used in shop work, except in courses 5 and 6 and the lathe tools made in course 1 and used in course 4, are purchased by the student with coupons which must be bought in advance at the office of the Secretary. The coal for courses in the forge shop must be paid for with coupons at the rate of one dollar for each course.

TECHNICAL REPORTS AND THESES.

Reports upon subjects assigned by the special departments, required of all students, one in each semester of the Sophomore, one in the Junior and one in the Senior year; one thesis required of each student in the second semester of the Senior year.

Students assigned for technical reports must confer with instructors in charge concerning subjects on or before October 15 for the first semester and March 15 for the second semester. The finished reports must be in instructor's hands by January 15 and May 15 for the respective semesters.

Each report counts as one-half credit.

Engineering Experiment Station.

STATION STAFF.

FRANK STRONG, PH. D., President.
FRANK O. MARVIN, A. M., Director. Civil Engineering.
EDGAR H. S. BAILEY, PH. D., Chemical Engineering.
ERASMUS HAWORTH, PH. D., Mining Engineering.
PERLEY F. WALKER, M. M. E., Mechanical Engineering.
GEORGE C. SHAAD, E. E., Electrical Engineering.

PURPOSES.

This department of University activity has been established for two reasons: First, to correlate and group together in a more systematic way the results of scientific investigation that heretofore has been done under the various departments; second, to foster, enlarge and direct this work, especially along lines of value to this state, and to supervise the publication and distribution of the results of engineering and industrial research work.

Considerable work of practical value has already been done in the past few years, such as investigations of Kansas building stone, of Kansas stone for macadam roads, of paving brick, the action of repeated stresses on concrete, of the shearing strength of concrete, of the properties of hydraulic cements, of the purification of sewage, of variations in the flow of sewage, of the waters of the state, both surface and underground, of the composition of Kansas oils and gases, of the flow of gases through nozzles, of the lubricating value of Kansas oils, of the application of chemistry to manufacturing industries, etc.

Much of this kind of material lies incomplete and unused in department records for the lack of funds to complete the investigations and an efficient organization to stimulate the work and bring out results for the public benefit.

The field to be covered, and in which there are many questions arising that can be investigated to the best advantage in the well-equipped laboratories of the University, is a very large one, including such subjects as structural materials, coals, ores of lead and zinc, gypsum, clays, hydraulic cements, oils, gases as they are used for illuminants or as they produce explosions in mines or elsewhere, the waters of the state, water supplies for potable and mechanical uses, the character and disposal of sewage and other waters, the influence of bacterial action on the design and operation of public sanitary works, hydraulic power plants, applications of electricity to service, chemistry in the arts, and many other lines of investigation of direct utility.

During the past year several lines of investigation of problems affecting engineering work have been under way. It is expected that results of some of these will be ready for publication in the shape of bulletins of the Station during the coming year.

The bulletins of the Station are issued in a special series with a consecutive numbering, the initial number having been published in the early days of 1910.

All communications with reference to the work of the Station or its publications should be addressed to the Director.

The Libraries.

CARRIE M. WATSON, Librarian.
EDITH M. CLARKE, Cataloguer.
CLARA S. GILLHAM, Loan Desk Assistant.
MARY M. SMELSER, Accession Assistant.
NELLIE BURNHAM, Reference Assistant.
SUSIE SHAFFER, Reference Assistant.
MARY A. COLLINS, Reference Assistant.
DORA RENN BRYANT, School of Engineering Assistant.
AMARETTE BULLENE WEAVER, School of Law Assistant.

The libraries of the University contain 71,545 volumes and 40,000 pamphlets. An anual appropriation of $12,500 is devoted to the purchase of books, and during the year 1911-'12 about 5000 volumes and 2000 pamphlets will be added. The books are selected with great care, and the reader is furnished with the latest and the best authorities in the various departments. When opportunity permits, rare and unusual books are secured. To these, under proper restrictions, the students may have access. The library is large enough to enable the student to prosecute research and to carry on original investigation. Source material, in American and European history, in the various language departments, in science, in mathematics and in other subjects is being constantly added, so that the investigator has ample facilities to carry on advanced original work. The library has been greatly strengthened during the last few years by the addition of many complete sets of journals of learned societies in the various departments of knowledge, and the current numbers of these journals are on file in the reading room.

THE UNIVERSITY LIBRARY.

The University library is in the Spooner Library Building, and is open every day in the year, Sundays and holidays excepted. Library hours are from eight A. M. to ten P. M. when the University is in session and, during vacation from eight A. M. to six P. M. Liberal facilities for using the library are offered to all members of the University. All books, except reference books and books too rare to be easily replaced, may be taken from the library by the students for three weeks. However, if a book is needed for a special purpose or a class reservation, it may be recalled by the Librarian, and must be returned at once, after notice is received.

BOOKSTACKS. There are five stories in the stack room of the library, each eight feet high, making all the books within easy reach. The stacks and the flooring of these rooms are of steel, making a fireproof depository for the books. Books are classified and arranged on the shelves by the Dewey system.

CATALOGUE. The catalogue of the library contains about 130,000 cards. It is arranged alphabetically both as to author and subject, and the author and subject cards are catalogued together. Cards are arranged in cases in general reading room.

THE GENERAL READING ROOM. The general reading room is a large, comfortable, well-equipped and well-lighted room, on the main floor of the Spooner Library. It is furnished with 200 electric lamps. In this room are about 1000 volumes of general reference books, cyclopedias, dictionaries, Poole's Index to Periodical Literature, and other books which are of special value for reference purposes.

DEPARTMENT READING ROOMS. The departments of German philosophy, Latin, English and education have reading rooms on the lower floor of the library, and the departments of American and European history, sociology and economics have the whole of the upper floor of the building.

PERIODICAL ROOM. The University provides in this room 756 periodicals and publications of learned societies and 425 newspapers published in Kansas. The list of periodicals includes almost all of the important publications of America and Europe.

OFFICES, ETC. The office of the Librarian, the office of the cataloguer, and the accession room adjoin the general reading room, and on the lower floor are storerooms.

DEPARTMENT LIBRARIES. Besides the books in Spooner Library Building, there are eleven departmental libraries in the different buildings of the University. They are placed in close conjunction with the various laboratories and lecture rooms, so as to be immediately accessible to students in scientific work.

THE LAW LIBRARY. The law library is located in Green Hall. It contains 6500 volumes.

THE ENGINEERING LIBRARY. This is located in the Marvin Hall. All works and periodicals relating to civil, mechanical and electrical engineering are placed here. A reading room is attached.

THE LAWRENCE PUBLIC LIBRARY.

The public library of Lawrence is open to students. This library contains 10,354 volumes, mainly of general literature and fiction, and 2250 public documents, and is a valuable supplement to the University library.

THE LIBRARY OF THE UNIV. APR 15 1931

Summary of Enrollment.

1910-'11.

SCHOOLS.	*Men.*	*Women.*	*Total.*
The Graduate School.	**101**	**55**	**156**
Summer Session, 1910	33	26	59
Regular Session	68	29	97
The College of Liberal Arts and Sciences.	**584**	**560**	**1,143**
Senior Class	106	89	195
Junior Class	88	114	202
Sophomore Class	128	141	269
Freshman Class	191	167	358
Unclassed Students	71	49	120
The School of Engineering.	**435**	....	**435**
Senior Class	78	....	78
Junior Class	69	....	69
Sophomore Class	119	....	119
Freshman Class	150	....	150
Specials	19	....	19
The School of Fine Arts.	**28**	**196**	**224**
Senior Class	1	23	24
Junior Class	....	15	15
Sophomore Class	1	26	27
Freshman Class	6	76	82
Specials	20	56	76
The School of Law.	**242**	**2**	**244**
Senior Class	52	1	53
Middle Class	59	....	59
Junior Class	124	1	125
Specials	7	....	7
The School of Pharmacy.	**73**	**5**	**78**
Senior Class	16	1	17
Junior Class	45	4	49
Sophomore Class	8	....	8
Freshman Class	3	....	3
Specials	1	....	1
The School of Medicine.	**80**	**19**	**99**
Fourth Year	17	2	19
Third Year	15	1	16
Second Year	17	1	18
First Year	31	1	32
Nurses	....	15	15
Total Enrollment Regular Session.	**1.542**	**838**	**2,378**
Names counted twice	142	60	220
	1,400	**778**	**2,176**
The Summer Session	204	186	390
Current Students in Summer Session	98	70	168
	106	**116**	**222**
Total Registration, 1910-'11.	**1,506**	**892**	**2,398**

K13uZa
1913/14

BULLETIN OF THE UNIVERSITY OF KANSAS

VOL. XIV. APRIL 15, 1913. No. 11

School of Engineering.

Announcements for 1913-'14.

LAWRENCE, KANSAS.

Published Semimonthly from January to June and Monthly
from July to December, inclusive, by the
University of Kansas.

UNIVERSITY OF ILLINOIS
AUG 31 1917
Administrative Library

Entered as second-class matter February 19, 1910, at the post office at
Lawrence, Kansas, under the Act of July 16, 1894.

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BOARD OF REGENTS.

March to July 1, 1913.

CHANCELLOR FRANK STRONG, Lawrence	*Ex officio.*
HON. CHARLES F. FOLEY	Lyons.
HON. RODNEY A. ELWARD	Castleton.
HON. GEORGE W. MARBLE	Fort Scott.
MISS RACHEL PUGH	Independence.
HON. A. B. REEVES	Dodge City.
HON. JAMES VANCE HUMPHREY	Junction City.

STATE BOARD OF ADMINISTRATION OF EDUCATIONAL INSTITUTIONS.

Term Beginning July 1, 1913.

MR. ED. T. HACKNEY, *President*, Wellington	Term	exp.	1917
MR. EDWARD W. HOCH, Marion	“	“	1915
MRS. J. M. LEWIS, Kinsley	“	“	1917
MR. D. M. BOWEN, *Secretary*, Pittsburg.			

UNIVERSITY CALENDAR.

Academic Year, 1912-'13.

Jan. 3, Friday—Christmas recess ends.
Feb. 3 to 7, Monday to Friday, inclusive—Semiannual examination.
Feb. 10, Monday—Second semester begins.
Feb. 12, Wednesday, Lincoln's birthday—Legal holiday.
Feb. 22, Washington's birthday—Legal holiday.
March 21 and 24, Friday and Monday—Easter recess, begins 5:30 P. M. Thursday.
April 11, Friday—First half-semester ends.
April 14, Monday—Second half-semester begins.
May 30, Friday, Memorial Day—Legal holiday.
June 2 to 6, Monday to Friday, inclusive—Annual examinations.
June 8, Sunday, 8 P. M.—Baccalaureate sermon.
June 9, Monday, 8 P. M.—Organ recital.
June 10, Tuesday, 10:30 A. M.—Annual Alumni address.
June 10, Tuesday, 8 P. M.—Chancellor's reception.
June 11, Wednesday, 10 A. M.—Commencement exercises.
June 12, Thursday—Opening of Summer Session.

Academic Year, 1913-'14.

Sept. 16, 17, Tuesday and Wednesday—Examination of candidates for admission. and presentation of certificates from high schools, academies, and other institutions.
Sept. 17, Wednesday—First semester begins.
Sept. 18, Thursday—Class work begins.
Sept. 19, Friday—General assembly of students and annual address, in University Hall, at 10 A. M.
Nov. 24, Monday—Second half-semester begins.
Nov. 27 and 28, Thursday and Friday—Thanksgiving recess, begins Wednesday noon.
Dec. 16, Tuesday, 8 P. M.—Christmas concert by Music department, School of Fine Arts.
CHRISTMAS RECESS—Saturday, Dec. 20, to Friday, Jan. 2, inclusive, begins noon Friday, Dec. 19.
Jan. 2, Friday—Christmas recess ends.
Feb. 2 to 6, Monday to Friday, inclusive—Semiannual examinations.
Feb. 9, Monday—Second semester begins.
Feb. 12, Wednesday, Lincoln's birthday—Legal holiday.
Feb. 22, Washington's birthday—Legal holiday.
April 10 and 13, Friday and Monday—Easter recess, begins 5: 30 P. M. Thursday.
April 10, Friday—First half-semester ends.
April 13, Monday—Second half-semester begins.
June 1 to 5, Monday to Friday, inclusive—Annual examinations.
June 7, Sunday, 8 P. M.—Baccalaureate sermon.
June 8, Monday, 8 P. M.—Organ recital.
June 9, Tuesday, 10: 30 A. M.—Annual Alumni address.
June 9, Tuesday, 8 P. M.—Chancellor's reception.
June 10, Wednesday, 10 A. M.—Commencement exercises.
June 11, Thursday—Opening of Summer Session.

CHRONOLOGICAL TABLE.

1855.—(December.) A university provided for in the first constitution of Kansas territory, at Topeka.
1857.—(June.) State University at Lawrence provided for by free-state legislature, Topeka.
1857.—(September.) Seminary of learning provided for in Lecompton constitution.
1858.—(April.) System of public instruction, including a university department, provided for in Leavenworth constitution.
1859.—(July.) State University provided for as at present, in Wyandotte constitution, now the constitution of the state of Kansas.
1861.—Congress set apart and reserved for the use and support of a State University seventy-two sections of land.
1863.—Lawrence selected as location for the University of Kansas.
1864.—The University organized by the legislature.
1865.—March 21, first meeting of the Board of Regents.
1866.—July 19, Regents elected the first Faculty of the University, consisting of Elial Jay Rice, A. M., David Hamilton Robinson, A. M., and Francis Huntington Snow, A. M.
1866.—North College erected.
1866.—September 12, first session of the University opened at North College.
1870.—Department of Engineering organized.
1872.—Fraser Hall erected and occupied.
1876.—Normal Department established.
1877.—Department of Music organized.
1878.—Department of Law organized.
1883.—Medical Hall (old Chemistry Building) erected.
1885.—Department of Pharmacy established.
1885.—Normal Department discontinued.
1886.—Snow Hall erected.
1891.—The Preparatory Department discontinued, the work being left to the high schools of the state.
1891.—The University reorganized and Schools of Arts, Engineering, Law, Fine Arts and Pharmacy established.
1894.—Spooner Library erected.
1894.—Chancellor's residence erected.
1895.—Blake Hall erected.
1896.—The Graduate School established.
1899.—The Fowler Shops erected.
1899.—The School of Medicine established.
1900.—Chemistry and Pharmacy Building erected.
1902.—Natural History Museum Building erected.
1904.—The name of the School of Arts changed to the College of Liberal Arts and Sciences.
1904.—Green Hall erected.
1905.—Full four-year course in medicine established.
1905.—Eleanor Taylor Bell Memorial Hospital erected.
1906.—Robinson Auditorium-Gymnasium erected.
1906.—Clinical Laboratory erected.
1906.—Nurses' Training School established.
1907.—Civil and Mechanical Engineering Building erected.
1908.—Mining Engineering Building erected.
1908.—Power plant and laboratories erected.
1909.—The School of Education and The Division of University Extension established.
1911.—First wing of Administration Building erected.
1911.—State Hospital erected at Rosedale.
1911.—Clay-working laboratory erected.

GENERAL INFORMATION.

THE GENERAL CATALOGUE of the University of Kansas is issued in the spring of each year. A copy will be sent free to any one desiring it.

SEPARATE CATALOGUES of the schools of the University are issued at the same time with the General Catalogue of the University. Separate catalogues will give complete information as to each school or department of the University. Prospective students of the Graduate School, the School of Engineering, the School of Fine Arts, the School of Law, the School of Pharmacy, the School of Medicine, the School of Education, the University Extension Division or the Summer Session will ask for the separate catalogue of the desired school. They are issued free of cost.

THE ALUMNI CATALOGUE of the University is issued at intervals, giving a list of the graduates of the University. Copies are sent free to graduates and former students of the University.

A HIGH-SCHOOL MANUAL is issued at intervals, giving in detail the requirements for entrance to the different schools of the University, together with suggestions as to methods, courses of study, laboratory equipment, and a list of accredited high schools.

SPECIAL BULLETINS are issued during the University year covering topics of importance to the University and the schools and colleges of the state.

THE UNIVERSITY CALENDAR is posted weekly upon the local bulletin board, announcing lectures, concerts, prizes, and other matters of public interest under the auspices of the University, and as soon as possible will be printed in sufficient numbers for distribution, on request, to high schools of the state and to graduates and former students.

For catalogues and other information, address

THE REGISTRAR,
UNIVERSITY OF KANSAS,
Lawrence, Kan

ADMINISTRATIVE OFFICERS.

FRANK STRONG, PH. D., CHANCELLOR.
FRANK W. BLACKMAR, PH. D., DEAN.
FRANK H. HODDER, PH. M., SECRETARY OF THE FACULTY.
GEORGE O. FOSTER, A. B., REGISTRAR.

ADMINISTRATIVE COMMITTEE.

FRANK W. BLACKMAR, *Chairman.*

FRANK H. HODDER.	CHARLES G. DUNLAP.
WILLIAM C. STEVENS.	FREDERICK E. KESTER.

For information about the Graduate School, not contained in this circular, write to the Registrar.

The School of Engineering.

The legislative Faculty of the Graduate School consists of professors and associate professors of the department in which graduate courses are offered. The Faculty of instruction includes, in addition to these, assistant professors who are conducting graduate courses.

FACULTY.

FRANK STRONG, A. B., 1884, A. M., 1893, PH. D., 1897, (Yale); LL. D., 1909, (Baker University). Chancellor of the University, and President of the Faculties, *1902*.*
(101 F.†) 1345 Louisiana.

PERLEY F. WALKER, B. M. E., 1896, (University of Maine); M. M. E., 1901, (Cornell). Dean and Professor of Mechanical Enginering, 1913; *1905*. (211 M.) 1301 Ohio.

FRANK OLIN MARVIN, A. B., 1871, A. M., 1874, (Allegheny). Advisory Dean, 1913; *1875*. (112 M.) 1603 Massachusetts.

EDGAR HENRY SUMMERFIELD BAILEY, PH. B., 1873, (Yale); PH. D., 1883, (Illinois Wesleyan). Professor of Chemistry and Metallurgy, and Director of Chemical Laboratories, *1883*.
(214 C.) 1101 Ohio.

CHARLES GRAHAM DUNLAP, A. B., 1883, A. M., 1899, (Ohio Wesleyan); LITT. D., 1892, (Princeton). Professor of English Literature, 1890; *1887*. (203 F.) 925 Kentucky.

ERAMUS HAWORTH, B. S., 1881, M. S., 1884, (University of Kansas); PH. D., 1888, (Johns Hopkins). Professor of Geology, Mineralogy, and Mining, and Superintendent of the Geological Survey, 1894; *1892*. (104 H.) 1503 Massachusetts.

WILLIAM CHASE STEVENS, B. S., 1885, M. S., 1893, (University of Kansas). Professor of Botany, 1899; *1889*.
(201 S.) 1121 Louisiana.

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* The date after each title indicates the year of appointment to the present rank; a second date denotes the year of first appointment in the University, when that fact is not indicated by the first date.

† Abbreviations:
B=Blake Hall.
C=Chemistry Building.
D=Dick Building Studios.
E=General Engineering Building.
F=Fraser Hall.
G=Green Hall.
L=Spooner Library.
Med=Medical Hall.
Mu=Museum of Natural History.
N=North College.
RG=Robinson Gymnasium.
S=Snow Hall.
Sh=Fowler Shops.
ML=Mechanical Laboratory.
PP=Power Plant.

WILLIAM ALEXANDER GRIFFITH, (Academy Julien, Paris). Professor of Drawing and Painting, *1899*.
(310 A.) 1200 Louisiana.

EUGENIE GALLOO, B. L., 1892, (University of Michigan); Académie de Paris, Brevet, 1881, Sorbonne, 1884, (University of France); A. M., 1895, (University of Kansas). Professor of Romance Languages and Literatures, 1900; *1892*.
(304 F.) 1324 Louisiana.

JAMES NAISMITH, A. B., 1887, (McGill University); M. D., 1898, (Gross Medical College); M. P. E., 1910, (Springfield Y. M. C. A. College). Professor of Physical Education, 1906; *1898*.
(RG.) 1635 Massachusetts.

GEORGE CARL SHAAD, B. S., 1900, E. E., 1905, (Penn. State College). Professor of Electrical Engineering, *1909*.
(2 M.) University Heights.

FREDERICK EDWARD KESTER, M. E., 1895; (Ohio State University); A. M., 1899, PH. D., 1905, (Cornell). Professor of Physics, *1909*. (204 B.) 1612 Louisiana.

HAMILTON PERKINS CADY, A. B., 1897, PH. D., 1903, (University of Kansas). Professor of Chemistry, 1911; *1899*.
(115 C.) 1535 Kentucky.

B. J. DALTON, B. C. E., 1890, (University of Kansas). Professor of Railway Engineering and Surveying, *1906*.
(118 M.) 1011 Indiana.

HARRY ALVIN MILLIS, A. B., 1895, A. M., 1896, (Indiana University); PH. D., 1899, (University of Chicago). Professor of Economics, 1912. (204 A.) 1006 Mississippi.

GRANDVILLE R. JONES, C. E., 1904, (Ohio State University); S. E., 1907, (Massachusetts Institute of Technology). Professor of Sanitary Engineering, 1912.
(209 M.) 1244 Louisiana.

HERBERT ALLAN RICE, C. E., 1897, (Ohio State Universiy). Professor of Mechanics and Structural Engineering, 1913; *1905*.
(202 M.) 1304 Ohio.

——————, Professor of Germanic Languages.

FREDERICK HORATIO BILLINGS, A. B., 1896, (Leland Stanford); A. M., 1897, (Harvard); PH. D., 1901, (Munich). Professor of Bacteriology, 1913; *1907*. (201 S.) 1209 Tennessee.

MARTIN EVERETT RICE, B. S., 1891, M. S., 1893, (University of Kansas). Secretary, and Associate Professor of Physics and Electrical Engineering, 1906; *1892*. (204 B.) 1223 Vermont.

CLINTON MASON YOUNG, B. S. in Mining, 1904, E. M., 1909, (Case). Associate Professor of Mining Engineering, *1906*.
(H.) 1227 Ohio.

HENRY WILBUR HUMBLE, LL. B., 1904, (University of Cincinnati); A. M., 1908, (Cornell). Associate Professor of Law, *1908*. (202 G.) University Heights.

CHARLES HAMILTON ASHTON, A. B., 1887, (Union); A. M., 1893, (Harvard); PH. D., 1909, (Munich). Associate Professor of Mathematics, 1910; *1903*. (108 M.) 1202 Ohio.

GEORGE JUSSEN HOOD, B. S., 1902, (University of Kansas). Associate Professor of Mechanical Drawing, 1911; *1902*. (302 M.) University Heights.

FRANK BURNETT DAINS, PH. B., 1890, M. S., 1891, (Wesleyan University); PH. D., 1898, (University of Chicago). Associate Professor of Chemistry, 1911. (102 C.) 1224 Louisiana.

WILLIAM ASBURY WHITAKER, JR., PH. B., 1904, (University of North Carolina); M. A., 1905, (Columbia). Associate Professor of Metallurgy, 1911. (310 C.) 1201 Tennessee.

F. H. SIBLEY, B. S., 1898, (Brown University); M. E., 1904, (Case School). Associate Professor of Mechanical Engineering, 1913, 1912. (305 M.) 1607 Tennessee.

CHARLES A. HASKINS,* B. S., 1910, University of Kansas). Associate Professor of Sanitary Engineering, 1913; *1911*. (209 M.) 1738 Mississippi.

FRANK EMERSON WARD, (Northern Indiana Normal School). Superintendent of Fowler Shops and Shop Instruction, 1899; *1889*. (Sh.) 1236 Oread Ave.

FREDERICK NEWTON RAYMOND, A. B., 1896, (University of Kansas); A. M., 1897, (Columbia). Assistant Professor of Rhetoric, *1901*. (107 M.) 808 Illinois.

CHARLES COCHRAN, (University of Colorado). Assistant Professor of Mechanical Drawing, *1906*. (302 M.) 1336 Kentucky.

FRANK EVERETT JONES, (Armour Institute). Assistant Professor of Carpentry and Pattern Making, *1903*. (Sh.) 1324 New Hampshire.

ALFRED HIGGINS SLUSS, B. S., in Mech. Eng., 1901, (University of Illinois). Assistant Professor of Mechanical Engineering, *1908*. (305 M.) 1133 Kentucky.

HERMAN CAMP ALLEN, A. B., 1904, (McPherson College); A. M., 1905, (University of Kansas). Assistant Professor of Chemistry, 1910. (204 C.) 1011 Alabama.

CLARENCE ANTHONY JOHNSON, B. S., 1906, (University of Nebraska). Assistant Professor of Electrical Engineering, 1911; *1908*. (2 M.) 1017 Alabama.

CLIFFORD CAUDY YOUNG, A. B., 1910, (University of Kansas). Assistant Professor of Chemistry, 1911; *1910*. (302 C.) 1015 Maine.

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* Assigned to state work under the State Board of Health.

HERBERT E. JORDAN, A. B., 1900, A. M., 1901, (McMasters University, Toronto); PH. D., 1904, (University of Chicago). Assistant Professor of Mathematics, 1911. (108 M.) 1600 Kentucky.

DAVID W. STRADLING, B. S., 1902, C. E., 1911, (Purdue). Assistant Professor of Civil Engineering, 1911. (306 M.) 1217 Tennessee.

EDMUND PENDLETON RANDOLPH DUVAL, B. S., 1901, (University of Texas); A. M., 1904, (Harvard). Assistant Professor of Mathematics, 1912. (108 M.) 1609 Tennessee.

FRED R. HESSER, B. S., (University of Kansas). Assistant Professor of Sanitary Engineering, 1913.

JOHN D. GARVER, B. S., 1910, (University of Kansas). Assistant Professor of Mechanical Engineering, 1913; 1912. (305 M.) 927 Louisiana.

MAY GARDNER, A. B., 1897, (University of Kansas). Instructor in Romance Languages, *1909*. (103 M.) 1200 Mississippi.

ALLEN ANDERS SEIPT, A. B., 1900, A. M., 1903, PH. D., 1906, (University of Pennsylvania). Instructor in German, 1910. (303 F.) 718 W. Elliott.

JOHN JEFFERSON WHEELER, A. B., 1906, (Indiana University). Instructor in Mathematics, 1911. (108 M.) 937 Alabama.

OSCAR WILLIAM MELIN, B. S. of C. E., 1910, (University of Wisconsin). Instructor in Engineering, 1911. (306 M.) 941 Kentucky.

HUBERT WILTFONG, Instructor in Forging, 1911. (Sh.) 1302 Tennessee.

JACOB OSCAR JONES, B. S., 1911, (University of Kansas). Instructor in Civil Engineering, 1911. (8 M.) 1400 Ohio.

WORTH HUFF RODEBUSH, A. B., 1912, (University of Kansas). Instructor in Chemistry, 1912. (115 C.) 1014 Mississippi.

LEON B. MCCARTY, A. B., 1910, A. M., 1912, (Ohio State University). Instructor in Rhetoric, 1912. (107 M.) 1201 Tennessee.

EPHRAIM EDGAR LANDRUM. Instructor in Patternworking, 1909. ing, 1909. (Sh.) 931 Maine.

————————. Instructor in Mathematics.

ANSEL HARTLEY STUBBS, A. B., 1913, (University of Kansas). Assistant Instructor in German, 1912. (303 F.) 746 Ohio.

SPARKS S. SCHOOLEY, B. S., 1913, (University of Kansas). Instructor in Electrical Engineering, 1913.

OSCAR ROCKLUND. Instructor in Foundry, 1913.

PURPOSE OF THE SCHOOL.

The School of Engineering is the scientific or technical school of the University. It offers what is, in the main, technical training in the various departments of engineering—civil, electrical, mechanical, mining, sanitary, chemical and architectural. The courses of study in these branches of engineering are designed first of all to furnish a broad and thorough training in mathematics, mechanics, drawing, and physical science, the fundamental subjects on which the more professional subjects are based. They are alike during the first year, and are nearly identical up to the end of the Sophomore year, but differ considerably thereafter, each emphasizing the subjects peculiar to itself and giving as much technical training as is consistent with the thorough inculcation of sound theory.

FOUR-YEAR AND FIVE-YEAR COURSES.

Two sets of courses of study are offered in the School of Engineering: (1) Regular four-year courses of study based upon the completion of fifteen units of high-school entrance work, as stated under "Subjects for Admission" below; (2) advanced four-year courses of study based upon the completion of one year of work in the College, making five years in all. The detailed programs of the advanced four-year courses of study are given following those of the regular four-year courses of study.

Any student in the School of Engineering may supplement his work in this school by work elsewhere in the University, subject, of course, to the particular requirements of the courses he wishes to enter.

ADMISSION TO THE SCHOOL.

There are two methods of admission to the School of Engineering of the University: first, by examination; second, by certificate.

1. By Examination.

Times and places of examination for admission to the School of Engineering are the same as for admission to the College. For schedules see The College, under the heading "Admission," page 110, or write the Registrar of the University. Candidates may divide the examination between two years, as noted.

2. By Certificate.

Nearly all students enter the School of Engineering by certificates from high schools, academies, and preparatory schools of other colleges and universities, and from military schools, accredited by the University. The candidate for admission by certificate must present either a certificate or other credential, as noted in connection with admission to the College. In general, the same rules apply in regard to admission by certificate to the School of Engineering as apply for admission to the College.

SUBJECTS FOR ADMISSION.

Fifteen units must be offered for entrance. Of these, nine must be those in the list of required subjects, the other six being selected from the optional list. Selection from this optional list is unrestricted, excepting that one unit only may be offered from the group of six subjects listed last in the column.

REQUIRED.		
Mathematics 1, 2, 3, algebra and plane and solid geometry,	3	units.
English 1, 2, 3	3	“
Physics	1	“
Foreign language—Two units in one of the following: French, German, Latin or Spanish,	2	“
Required	9	“

OPTIONAL.		
Latin 1, 2, 3	–	units.
German 1, 2, 3	–	“
French 1, 2, 3	–	“
Greek 1, 2, 3	–	“
Spanish 1, 2	–	“
Greek and Rom. hist.,	1	“
Mediæval and modern history	1	“
English history	1	“
American history	1	“
Chemistry	1	“
Higher algebra	½	“
Plane trigonometry	½	“
Physical geog.	½ or 1	“
Botany	1	“
Physiology	1	“
Zoölogy	1	“
Biology	1	“
Economics	½ or 1	“
Civics	½	“
Advanced arithmetic, if taken after first year of algebra	½	“
Free-hand or mechanical drawing	1	“
Manual training	2	“
One unit only may be offered from the following group:		
Stenography	½	“
Bookkeeping	½	“
Commercial law	½	“
Commercial geog.	½	“
Agriculture	½ or 1	“
Psychology	½	“

DEFICIENCIES AND UNIT OF ENTRANCE.

The candidate may be admitted to the Freshman class although deficient in some of the requirements as laid down above, provided such deficiency does not exceed two units. All deficiencies must be made good within such time as may be fixed in each individual case by the Dean of the School of Engineering.

Applicants for admission are advised to come without deficiencies, and to be especially well prepared in algebra and geometry.

An entrance unit represents five periods a week, of not less than forty minutes each, for thirty-five weeks.

ACCREDITED SCHOOLS.

The list of schools accredited to the School of Engineering is practically the same as that of schools accredited to the College.

FOREIGN LANGUAGES.

ENTRANCE WITHOUT FOREIGN LANGUAGE.

High-school graduates presenting fifteen units from the list of accredited entrance subjects, but with no foreign language, will be admitted to the School of Engineering without entrance conditions, but will be required to take two full years of German, French or Spanish in the University, instead of the one year of foreign language regularly required.

ADVANCED CREDIT IN FOREIGN LANGUAGE.

Advanced credit for work in preparatory schools will be given upon examination only, excepting for the following provisions in foreign language: Graduates of high schools presenting four units in not more than two foreign languages, one of these being in a modern language, will be allowed to substitute five hours of optional subjects in the University for five hours of the regularly required modern language in the engineering courses of study. When presenting five or more units in not more than two foreign languages, two of these units being in a modern language, they will be allowed to substitute ten hours of optional courses for the ten hours of modern language regularly required. The choice of these optional courses shall be subject to the approval of the student's adviser and the Dean of the School of Engineering. For times and places of examination for advanced credit, see The College, p. 110.

ADMISSION TO ADVANCED STANDING.

For an advanced rank, the applicant must have completed all of the courses of the curriculum below the rank for which he applies, including the entrance requirements, or their substantial equivalent, as determined by the committee on advanced standing. Application for credits toward advanced standing should be made to the Dean of the School of Engineering.

SPECIAL STUDENTS.

Opportunity is given in the School of Engineering for the admission of persons of mature years who desire to pursue some special lines of work, without following any prescribed course of study or becoming candidates for a degree.

The admission of such special students is directly under the control of the Dean of the School of Engineering, whose certificate of acceptance must be presented to the Registrar before registration. Applicants for admission as special students must present satisfactory evidence of proper preparation for the courses desired, and must also meet other requirements as fixed by the Faculty.

Special students are subject to the same regulations as are regular students with regard to the quality of work performed and attendance at recitations and examinations, but not as to number of courses to be pursued.

REGISTRATION AND ENROLLMENT.

All candidates for admission to the School of Engineering having high-school certificates, and all students intending to pursue their studies in the ensuing year, should present themselves for registration at the University on September 17 to 20, inclusive, 1913. Preliminary registration may be made through the mails by forwarding to the Registrar a certified transcript of preparatory work, this registration to be completed by the Registrar during the opening week of the following semester.

The Dean of the School of Engineering is charged with the execution of all University and Faculty rules relating to the enrollment of students in classes and their choice of courses.

Upon registration, each student will receive from the Registrar a certificate of his standing, which he will present to the Dean of the School, who is charged with the duty of enrollment of students in classes, selection and arrangement of courses, and assignment of hours.

INADEQUATE PREPARATION.

When a student shows by his current work insufficient preparation for any course, he may be required to make good such deficiency in any manner prescribed by his instructor and approved by the Dean of the School.

DEGREES GRANTED.

All courses of study in the School of Engineering lead to the degree of bachelor of science. All work for higher degrees is under supervision of the Faculty of the Graduate School. The degree of master of science may be granted to graduates of the School of Engineering after completion of one year's work in residence.

Graduates in engineering from this University, and masters of science who have received their degrees through the Graduate Faculty, are eligible to the professional degrees of civil engineer, electrical engineer, mechanical engineer, mining engineer, and chemical engineer, whichever is appropriate to the undergraduate course taken. Candidates for these degrees must have spent at least three years' actual time in professional practice, or in positions of responsibility, in the design, construction or operation of engineering works, and must furnish detailed and satisfactory evidence as to the nature and extent of this practice.

The candidate must submit an engineering thesis, accompanied by detailed explanations, drawings, specifications, estimates, etc., and embodying the results of his own work or observation. If approved, the thesis and all accompanying material becomes the property of the University.

The thesis for any professional degree must be delivered to the Dean of the School of Engineering on or before May 15.

THE COURSE AND THE CREDIT HOUR.

As generally used throughout the Catalogue, the word "course" refers to a particular study or subject, as the work of a class during a semester, to complete which some specified amount of work is necessary. The ground covered in each course is indicated in that portion of the Catalogue devoted to Description of Courses. Any one subject, like German or calculus, may be divided into several courses, no student being allowed to enroll in more than one course in that subject at one time. Such courses are arranged so as to be taken in succession. When the word "course" is used in any sense different from this it is coupled with other words, such as "course of study," meaning a complete program for a full semester or for the full period of years usually required to secure a degree.

The amount of work required to complete a course is measured in "credit hours." One credit hour in the School of Engineering represents an amount of work which is estimated to require three hours per week, throughout a semester, of the time of a student of average ability. These three hours may be divided in any ratio between class attendance and outside work, most courses being in the ratio of one hour in class to two hours of outside preparation; of two hours in class to one hour of outside preparation or report writing; or all three required in class with no outside preparation. In the descriptions of courses the number of credit hours for each is stated.

GRADES AND FAILURES.

The satisfactory completion by the student of each course is determined by the instructor in charge, and the quality of the work is indicated by the numeral 1, 2, or 3, thus establishing the grade attained. Grade 1 indicates that the work of the student has been excellent in quality; grade 2 indicates that the work of the student has been reasonably good; grade 3 indicates that the student's attainments are sufficient to enable him to pursue the succeeding courses in the same or other departments.

Any grade or rank below grade 3 is recorded as a failure, indicated by the letter F. Such courses must be repeated in regular classes, unless arrangements are made with the Dean of the School for private tutoring under some special instructor approved by the head of the department concerned. Each failure must be made good as soon as the course is again given regularly in the School.

In case the work of the student in any course is of satisfactory grade but incomplete in some respects, the instructor may grade him as "conditioned," indicated by the letter C. Such "condition" may be removed by special examination, or by satisfactory completion of assigned work. When the instructor reports the student as qualified, the record is turned in by the instructor on a special card issued by the Dean of the School. In case the condition is not removed by the time the course is given again in regular schedule, it becomes a failure and the course must be repeated.

When a student is absent from the final examination, or has done none of the regular work of a course, the instructor grades him as "not examined," indicated by the letters NX. In all respects relative to making up the work, the grade of NX is the same as F.

Weekly reports on the work of each student are made by his instructors, and are on file in the office of the Dean. At the end of each semester all final grades are recorded in the books of the Registrar of the University; and at that time the parent or guardian of each student will be furnished, on request, a copy of the entries relating to that student.

Absence from examination or failure in more than one-third of his work in any one semester severs a student's connection with the University, and that connection can be renewed only through the Dean of the School.

Any withdrawal from school or from any course must be authorized by the Dean; otherwise the student's absence will be construed as failure.

EXAMINATIONS.

Regular examinations in the work of scheduled courses are held at times determined by the University Council. In determining the final grade of a student in any course the instructor may establish an average between the grades in final examination, in daily class work, and in mid-semester "quizzes," on such basis as he may see fit.

FEES.

Matriculation fee, for residents of the state	$5.00
for nonresidents	10.00
Incidental fee per school year, for residents of the state,	10.00
for nonresidents	20.00
Diploma fee, at graduation	5.00

COST OF MATERIALS.

In all laboratory and shop courses the student is charged for the materials and supplies he consumes in his work. These charges are payable in advance at the office of the University Secretary by the purchase of a book of coupons receivable for materials in any course, or by the payment of a fixed amount for a course in which the material can not be issued to each student individually. A schedule of these fixed fees, varying from 50 cents to $4, is posted in Marvin Hall and in the office of the University Secretary. In those courses where a large amount of material is used by the student and paid for with coupons, the total cost for any one course may reach or occasionally exceed $10.

Those students taking summer field work will be charged the actual cost of living and incidental expenses.

EXPENSE FOR INSPECTION TRIPS, ETC.

Students should make provision for expenses of about $40 in the Junior or Senior year, or both, for inspection trips to engineering works. See "Inspection Trips" at the end of "Description of Courses," page 261.

PROGRAM OF STUDIES.

The courses of study in the School of Engineering are almost entirely prescribed. The work is in the main technical, and requires preparation of a high order, especially in mathematics. It also requires continuous effort in the courses themselves, which call for the entire time of the student to succeed satisfactorily. Students are required to enroll in the courses in the order in which they are scheduled, any course scheduled in an earlier year having precedence over those in a later year.

The work of the Freshman year is common to all students of the School of Engineering, so that a choice between the several lines of engineering need not be made until after a year's experience with college life. As a further aid in making an intelligent choice, the general aims of the several courses are here briefly stated.

CIVIL ENGINEERING.

The first aim is to impart as broad a scientific training as the length of the course of study and the essential professional studies will allow, so that as many avenues to successful service as possible may be open to the graduate. Along professional lines, emphasis is laid first on work in surveying and field methods, as these are of special value to young engineers; second, on mechanics and its applications to the design of roofs and bridges and other structures; third, on railway location and construction; fourth, on hydraulics and its applications to irrigation and canal work; fifth, on water supply, sewerage, and roads and pavements. Stress is placed on the study of principles, as being the knowledge not likely to be acquired in after-life.

MUNICIPAL AND SANITARY ENGINEERING.

This course of study is a modification of that in civil engineering, and is intended for those desiring a more extensive study and a more thorough training in general sanitary science and in municipal and sanitary engineering practice. The program of study is practically the same as in civil engineering, except that during the Junior and Senior years the railroad work and the work in bridge designing are replaced by studies more closely related to public sanitation and municipal engineering practice.

This new added work includes a somewhat specialized course in bacteriology, particularly in its relation to water supply and sewerage; a short lecture and laboratory course in the chemical analysis of water; a broad and general study of sanitary science as related to public health problems; courses in the design of engineering structures related to sewage disposal and water purification; and a study of the theory and practice of reinforced concrete construction. The course of study also aims, by means of work in the sanitary laboratory and engineering experiment station, by visits of inspection to engineering works of interest to sanitary engineers, and by means of papers and informal discussions in the journal meetings, to train the student's judgment in regard to sanitary problems, and to strengthen his grasp upon the regular classroom studies.

ELECTRICAL ENGINEERING.

The course of study in electrical engineering is designed to train the student in those fundamental principles of mathematics, physics, chemistry, mechanics, and electricity which form the basis of all successful engineering work. The laboratory and shop work is arranged to develop and to encourage individual skill and ingenuity. Such experience in practical electrical work as is possible is also included. The aim of the entire course of study is to develop in the student those qualities that are essential to the professional engineer as well as those that are essential to the electrical artisan. The thesis involves original investigation.

MECHANICAL ENGINEERING.

In this course of study the aim is to give the student the broadest possible training in the fundamental sciences, with especial emphasis on machine construction and design, properties of structural materials, fundamentals of power generation with engine design, and manufacturing methods, for the purpose of preparing him for any one of the many lines of work coming under the designation of mechanical engineering. Freedom of options in the Senior year permits specialization in any one of the following lines: steam engineering and power-plant work; gas engineering; industrial or mill engineering, for general manufacturing; refrigeration engineering; or hydraulic power development. Particular attention is given to the science of management of manufacturing plants.

MINING ENGINEERING.

The object of the course of study in mining engineering is to qualify students for work in prospecting, mining, milling, and smelting, in accordance with modern scientific principles. The course of study includes a sufficient requirement in language work to give the student a good knowledge of English and foreign language, and a sufficient number of scientific and technical subjects—mathematics, engineering, chemistry, metallurgy, mining, mineralogy, and geology—so that upon the completion of the course of study he may be well qualified for specializing along any line which his future life may make desirable.

CHEMICAL ENGINEERING.

This course of study affords students an opportunity to specialize in chemistry, and to fit themselves for positions as chemists, managers, or superintendents of manufacturing plants where the work is based on chemical science. These would include such industries as those of iron, zinc, gold, and silver smelting and refining, the making of fertilizers, clay working, sugar refining, dyeing, bleaching, gas making, cement making, or general chemical manufacture. This course of study is broad enough for general training, and may be made special enough for technical work.

ARCHITECTURAL ENGINEERING.

This course of study is designed to train men to deal with the structural side of building design and construction. It is arranged to follow in a general way the plan of work required in the Civil Engineering course of study and, in common with all of the work given in the School of Engineering, aims to develop the general scientific training which forms the basis of successful engineering practice.

WORK REQUIRED FOR GRADUATION.

The different courses of study outlined below are each designed to include 138 credit hours of work during the regular school years, and two periods of summer work as indicated. In those courses of study requiring only one period of summer work, the total is 139 credit hours; and in those requiring no summer work, the total is 140 credit hours.

DEGREE GRANTED.

The degree of Bachelor of Science in Civil (Electrical, Mechanical or other named course of study) Engineering is granted upon the completion of one of the following courses of study and the diploma given states the particular course of study pursued by the student.

COURSES OF STUDY.

(The schedule of hours of classes is posted each semester on the bulletin boards of the various buildings. The hours at which classes meet are stated in the Description of Courses as nearly as they can be determined before the schedules are made up.)

WORK IN COMMON.

FRESHMAN YEAR.

All students of the School of Engineering pursuing the regular four-year courses of study (except the students of Architectural Engineering—see p. 220) have work in common during the Freshman year. The differentiation between courses of study begins in the Sophomore year. For definitions of hours and credits see "The Course and the Credit Hour," page 206.

The foreign language chosen must be carried throughout the year, five hours each semester. The selection of the language courses will depend on the amount and kind of language offered for entrance.

First Semester, 17 credit hours.

Course Number.	*Subject.*	*Credit hrs.*
Mathematics 2	College Algebra	3
Mathematics 3	Plane Trigonometry	2
German, French, or Spanish	Course as approved	5
English 1 E	Rhetoric I	3
Mech. Drawing 1	Free-hand Drawing	1⅓
Mech. Drawing 2	Mechanical Drawing	⅔
Mech. Drawing 4, or Shop Work 1, and Shop Work 2	Machine Drawing Forging and Bench Work Woodworking and Molding	2
	Engineering Lectures.*	
	Gymnasium, 3 hours per week.†	

Second Semester, 17 credit hours.

Course Number.	*Subject.*	*Credit hrs.*
Mathematics 4 E	Analytic Geometry and Theory of Equations	5
German, French, or Spanish	Course as approved	5
English 2 E	Rhetoric II	2
Mech. Drawing 3	Descriptive Geometry	3
Mech. Drawing 4, or Shop Work 1, and Shop Work 2	Machine Drawing Forging and Bench Work Woodworking and Molding	2
	Gymnasium, 3 hours per week.†	

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* See "Engineering Lectures," page 260.

† See "Physical Education," page 257.

CIVIL ENGINEERING.

SOPHOMORE YEAR.

First Semester, 17½ credit hours.

Course Number.	*Subject.*	*Credit hrs.*
Mathematics 5 E	Calculus I	5
Physics 1 E	General Physics	5
Civil Engineering 2	Surveying	2
Geology 1	Elementary Geology	5
	Technical Report I‡	½

Second Semester, 16½ credit hours.

Mathematics 6 E	Calculus II	3
Physics 2 E	General Physics	5
Civil Engineering 2	Surveying	3
Mech. Engineering 5	Engines and Boilers	3
Civil Engineering 1	Topographical Drawing	2
	Technical Report II‡	½

Summer Work.

Civil Engineering 3	Field Work, 4 weeks.	

JUNIOR YEAR.

First Semester, 18 credit hours.

Mechanics 50	Mechanics	5
Civil Engineering 58	Railway Surveying	5
Civil Engineering 50	Railway Drawing	1
Chemistry 2	Advanced Inorganic Chemistry	4
English 50 E	Advanced Composition	3

Second Semester, 16½ credit hours.

Mechanics 51	Strength of Materials	4
Mechanics 52	Testing Laboratory	1
Civil Engineering 57	Railway Location	3
Chemistry 5 E	Engineering Chemistry	3
Civil Engineering 56	Roads and Pavements	2
Civil Engineering 51	Graphical Statics	3
	Technical Report III‡	½

Summer Work.

Civil Engineering 53	Field Work, 4 weeks.	

SENIOR YEAR.

First Semester, 17½ credit hours.

Civil Engineering 68	Hydraulics	3
Civil Engineering 60	Hydraulic Laboratory	1
Civil Engineering 61	Roofs and Bridges	5
Civil Engineering 55	Masonry	3
Civil Engineering 59 or Elec. Engineering 60	Sewerage and Water Supply El. of Elec. Engineering	4
	Thesis‡	1
	Technical Report IV‡	½

Second Semester, 18 credit hours.

Civil Engineering 52 ...	Contracts and Specifications	3
Civil Engineering 54 ...	Cement Laboratory	1
Civil Engineering 62 ...	Bridge Design	5
Civil Engineering 65 ...	Reinforced Concrete	3
	Optional	4
	Thesis‡	2

MUNICIPAL AND SANITARY ENGINEERING.

SOPHOMORE YEAR.

The same as in Civil Engineering.

JUNIOR YEAR.

First Semester, 18 credit hours.

Course Number.	*Subject.*	*Credit hrs.*
Mechanics 50	Mechanics	5
Civil Engineering 59 ...	Sewerage and Water Supply....	4
Chemistry 2	Advanced Inorganic Chemistry..	4
Civil Engineering 67 ...	Municipal Drawing	2
English 50 E	Advanced Composition	3

Second Semester, 17½ credit hours.

Civil Engineering 69 ...	Sanitary Science	3
Civil Engineering 56 ...	Roads and Pavements	2
Civil Engineering 70 ...	Sanitary Laboratory	1
Civil Engineering 54 ...	Cement Laboratory	1
Mechanics 51	Strength of Materials	4
Mechanics 52	Testing Laboratory	1
Chemistry 3	Qualitative Analysis	4
	Sanitary Journal	1
	Technical Report III‡	½

SENIOR YEAR.

First Semester, 17½ credit hours.

Civil Engineering 68 ...	Hydraulics	3
Civil Engineering 60 ...	Hydraulic Laboratory	1
Civil Engineering 61 ...	Roofs and Bridges	5
Civil Engineering 55 ...	Masonry	3
Chemistry 56 E	Water Analysis	5
	Technical Report IV‡	½

Second Semester, 18 credit hours.

Civil Engineering 52 ...	Contracts and Specifications	3
Civil Engineering 64 ...	Sanitary Design	5
Civil Engineering 65 ...	Reinforced Concrete	3
	Sanitary Journal	1
	Optional	3
	Thesis‡	3

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‡ See "Technical Reports and Theses," page 260.

ELECTRICAL ENGINEERING.

SOPHOMORE YEAR.

First Semester, 16½ credit hours.

Course Number.	*Subject.*	*Credit hrs*
Mathematics 5 E	Calculus I	5
Physics 1 E	General Physics	5
Chemistry 2	Advanced Inorganic Chemistry	4
Mech. Engineering 1	Machine Drafting	1
Shop Work 3	Pattern Making	1
	Technical Report I‡	½

Second Semester, 17½ credit hours.

Mathematics 6 E	Calculus II	3
Physics 2 E	General Physics	5
Chemistry 3	Qualitative Analysis	4
Mech. Engineering 3	Elementary Machine Design	3
Mech. Engineering 4	Steam Machinery	2
	Technical Report II‡	½

Summer Work.

Shop Work, 4 weeks, 44 hours per week.

JUNIOR YEAR.

First Semester, 17½ credit hours.

Mechanics 50	Mechanics	5
Elec. Engineering 50	Dynamo Machinery	3
Elec. Engineering 54	Electrical Laboratory	1½
Physics 52	Theory of Electricity	3
Physics 60 E	Electrical Measurements I	1½
Mech. Engineering 52	Heat Engine Theory	3
	Technical Report III‡	½

Second Semester, 18 credit hours.

Elec. Engineering 51	Theory of Alternating Currents	5
Elec. Engineering 55	Electrical Laboratory	1½
Mech. Engineering 53	Mechanics of the Steam Engine	2
Mechanics 51	Strength of Materials	4
Mechanics 52	Testing Laboratory	1
English 50 E	Advanced Composition	3
Physics 61	Electrical Measurements II	1½

SENIOR YEAR.

First Semester, 18 credit hours.

Elec. Engineering 52	Advanced Dynamo Machinery	5
Elec. Engineering 56	Advanced Electrical Laboratory,	1½
Civil Engineering 71	Surveying	3
Mech. Engineering 65	Heat Engine Laboratory	2
Chemistry 64	Physical Chemistry I	5
	Thesis‡	1
	Technical Report IV‡	½

Second Semester, 17 credit hours.

Elec. Engineering 58...	Electric Power Transmission....	5
Elec. Engineering 57...	Electric Lighting	3
Civil Engineering 52...	Contracts and Specifications....	3
	Optional	3
	Thesis‡	3

One extended inspection trip is required during the Junior or the Senior year. (See page 261.)

MECHANICAL ENGINEERING.

SOPHOMORE YEAR.

First Semester, 17½ credit hours.

Course Number.	*Subject.*	*Credit hrs.*
Mathematics 5 E	Calculus I	5
Chemistry 2	Advanced Inorganic Chemistry..	4
Economics I, or ...... Ger., French, or Span..	Elements of Economics, or... Advanced Language course as approved	3
Mech. Engineering 1....	Machine Drafting	1
Mech. Engineering 2....	Mechanism	3
Shop Work 3..........	Pattern Making	1
	Technical Report I‡...........	½

Second Semester, 17½ credit hours.

Mathematics 6 E	Calculus II	3
Physics 1 E	General Physics	5
Mech. Engineering 6....	Steam Engineering	4
Chemistry 5 E	Engineering Chemistry	3
Shop Work 4.......... Shop Work 5..........	Bench work .... Lathe Work	2
	Technical Report II‡..........	½

Summer Work.

Shop Work, 4 weeks, 44 hours per week.

JUNIOR YEAR.

First Semester, 18 credit hours.

Mech. Engineering 51...	Thermodynamics	4
Mech. Engineering 64...	Mechanical Laboratory	1
Physics 2 E............	General Physics	5
Mechanics 50	Mechanics	5
Metallurgy 61 E	Metallurgy I	3

Second Semester, 16½ credit hours.

Mech. Engineering 50...	Machine Design	4
Mech. Engineering 54...	Heating and Ventilation........	2
Mech. Engineering 69...	Shop Administration	2
Mechanics 51	Strength of Materials..........	4
Mechanics 52	Testing Laboratory	1
English 50 E	Advanced Composition	3
	Technical Report	½

Summer Work.

Commercial work or four weeks of Shop Practice.

SENIOR YEAR.

First Semester, 18 credit hours.

Mech. Engineering 56	Steam Engine Design	2
Mech. Engineering 67	Thesis	1
Civil Engineering 68	Hydraulics	3
Civil Engineering 60	Hydraulic Laboratory	1
Civil Engineering 71	Surveying	3
Elec. Engineering 50	Dynamo Machinery	3
Elec. Engineering 54	Electrical Laboratory	1½
	Technical Report‡	½
OPTIONAL.		
Mech. Engineering 61	Structural Design	3
Mech. Engineering 58	Gas Engine Design I	
Mech. Engineering 60	Hydraulic Design	
Mech. Engineering 55	Refrigeration	

Second Semester, 16½ credit hours.

Mech. Engineering 65	Heat Engine Laboratory	2
Mech. Engineering 69	Works Management	2
Mech. Engineering 67	Thesis	2
Civil Engineering 52	Contracts and Specifications	3
Elec. Engineering 53	Alternating Currents	3
Elec. Engineering 55	Electrical Laboratory	1½
OPTIONAL.		
Mech. Engineering 57	Steam Turbine Design	3
Mech. Engineering 59	Gas Engine Design II	
Mech. Engineering 62	Industrial Plant Design	
	Other approved engineering subject	

One extended inspection trip is required during the Junior or the Senior year. (See page 261.)

MINING ENGINEERING.

SOPHOMORE YEAR.

First Semester, 18½ credit hours.

Course Number.	*Subject.*	*Credit hrs.*
Mathematics 5 E	Calculus I	5
Geology I	Elementary Geology	5
Chemistry 2	Advanced Inorganic Chemistry	4
Civil Engineering 2	Surveying	2
Mech. Engineering 1	Machine Drafting	1
Shop Work 4 (modified)	Bench and Lathe Work	1
	Technical Report I‡	½
	Mining Journal	

Second Semester, 18½ credit hours.

Physics 1 E	General Physics	5
Chemistry 3	Qualitative Analysis	4
Civil Engineering 2	Surveying	3
Mineralogy 1 E	Elementary Mineralogy I	5
Mining Engineering 60	Mining Drawing	1
	Technical Report II‡	½
	Mining Journal	

Summer Work.

Civil engineering 3	Field work, 4 weeks.

JUNIOR YEAR.

First Semester, 18½ credit hours.

Mining Engineering 50	Mining	5
Mechanics 50	Mechanics	5
Geology 52	Economic Geology I	3
Chemistry 54	Quantitative Analysis I	5
	Technical Report III‡	½
	Mining Journal	

Second Semester, 17½ (or 18½) credit hours.

Physics 2 E	General Physics	5
Mechanics 51	Strength of Materials	4
Mechanics 52	Testing Laboratory	1
Metallurgy 57	Assaying	5
Geology 53	Economic Geology II	2
Mining Engineering 57	Mining Law	(-)1
	Technical Report IV‡	½
	Mining Journal.	

Summer Work.

Mining Engineering 59	Field Work.

SENIOR YEAR.

First Semester, 17 credit hours.

Mining Engineering 51	Ore Dressing	3
Mining Engineering 52	Power, Extraction, etc	5
English 50 E	Advanced Composition	3
Mining Engineering 58	Thesis	1
	Optional	5
	Mining Journal	

Second Semester, 15½ (or 16½) credit hours.

Mining Engineering 51	Ore Dressing	3
Mining Engineering 53	Sampling and Exploitation (*a*)	2½
Mining Engineering 57	Mining Law	(-)1
Civil Engineering 52	Contracts and Specifications	3
Mining Engineering 58	Thesis	2
	Mining Journal	
Metallurgy 62 E	Metallurgy II	5

CHEMICAL ENGINEERING.

SOPHOMORE YEAR.

First Semester, 17½ credit hours.

Course Number.	*Subject.*	*Credit hrs.*
Mathematics 5 E	Calculus I	5
Chemistry 2	Advanced Inorganic Chemistry	5
Physics 1 E	General Physics	5
Mech. Engineering 1	Machine Drafting	1
Shop Work 3	Pattern Making	1
	Technical Report I‡	½

Second Semester, 17½ credit hours.

Chemistry 3	Qualitative Analysis	5
Physics 2 E	General Physics	5
Mineralogy 1 E	Elementary Mineralogy I	5
Shop Work 4	Bench Work	2
Shop Work 5	Lathe Work	
	Technical Report II‡	½

JUNIOR YEAR.

First Semester, 18½ credit hours.

Chemistry 4	Organic Chemistry I	5
Chemistry 54	Quantitative Analysis I	5
Mechanics 50	General Mechanics	5
English 50 E	Advanced Composition	3
	Technical Report III‡	½

Second Semester, 19½ credit hours.

Chemistry 51 A	Industrial Chemistry: Inorganic,	3
Chemistry 55	Quantitative Analysis II	5
Chemistry 60	Organic Chemistry II	5
Mechanics 51	Strength of Materials	4
Mechanics 52	Testing Laboratory	2
	Technical Report IV‡	½

SENIOR YEAR.

First Semester, 17 credit hours

Chemistry 51 B	Industrial Chemistry: Organic	2
Chemistry 64	Physical Chemistry	5
Metallurgy 61 E	Metallurgy I	3
	Optional from Chemistry Department, 7 hours, or Optional 5 hours and Thesis 2 hours	7

Second Semester, 17 credit hours.

Chemistry 65	Physical Chemistry	5
Metallurgy 57	Assaying	3
Metallurgy 62	Metallurgy II	3
Civil Engineering 52	Contracts and Specifications	3
	Thesis‡	3

ARCHITECTURAL ENGINEERING.

FRESHMAN YEAR.

First Semester, 17 credit hours.

Course Number.	*Subject.*	*Credit hrs.*
Mathematics 2	College Algebra	3
Mathematics 3	Plane Trigonometry	2
German, French, or Spanish	Course as approved	5
English 1 E	Rhetoric I	3
Arch. Engineering I	Free-hand Drawing	2
Mech. Drawing 2 (Modified)	Mechanical Drawing	2
	Engineering Lectures.	
	Gymnasium, 3 hours per week.	

Second Semester, 17 credit hours.

Mathematics 4 E	Analytic Geometry and Theory of Equations	5
German, French or Spanish	Course as approved	5
English 2 E	Rhetoric II	2
Mech. Drawing 3	Descriptive Geometry	3
Arch. Engineering 2	Architectural Drawing	2
	Gymnasium, 3 hours per week.	

SOPHOMORE YEAR.

First Semester, 17½ credit hours.

Arch. Engineering 3	Architectural Design I	3
Arch. Engineering 5	History of Architecture I	2
Mathematics 5 E	Calculus I	5
Physics 1 E	General Physics	5
Civil Engineering 2	Surveying	2
	Technical Report I‡	½

Second Semester, 16½ credit hours.

Arch. Engineering 4	Architectural Design II	3
Arch. Engineering 6	History of Architecture II	2
Physics 2 E	General Physics	5
Mathematics 6 E	Calculus II	3
Mech. Engineering 5	Engines and Boilers	3
	Technical Report II‡	½

JUNIOR YEAR.

First Semester, 18 credit hours.

Arch. Engineering 7	Architectural Design III	3
Mechanics 50	Mechanics	5
Chemistry 2	Advanced Inorganic Chemistry	4
English 50 E	Advanced Composition	3
Elect. Engineering 64	Elec. Engineering for Architects,	3

Second Semester, 16½ credit hours.

Arch. Engineering 8	Architectural Design IV	3
Arch. Engineering 10	Sanitary Construction	2
Economics 1	Elements of Economics	3
Mechanics 51	Strength of Materials	4
Mechanics 52	Testing Laboratory	1
Civil Engineering 51	Graphical Statics	3
	Technical Report III‡	½

SENIOR YEAR.

First Semester, 17½ credit hours.

Arch. Engineering 11	Architectural Engineering I	4
Civil Engineering 68	Hydraulics	3
Civil Engineering 60	Hydraulic Laboratory	1
Civil Engineering 61	Roofs and Bridges	5
Civil Engineering 55	Masonry	3
	Thesis	1
	Technical Report IV‡	½

Second Semester, 18 credit hours.

Arch. Engineering 9	Steel Construction	3
Arch. Engineering 12	Architectural Engineering II	4
Civil Engineering 52	Contracts and Specifications	3
Civil Engineering 54	Cement Laboratory	1
Civil Engineering 65	Reinforced Concrete	3
Mech. Engineering 54	Heating and Ventilation	2
	Thesis	2

ADVANCED COURSES OF STUDY

Based upon one year of selected work in the College.

REQUIREMENTS FOR ADMISSION.

To be admitted to these courses of study the student must have completed all of the entrance requirements for admission to the College, and have completed thirty credit hours of work in the College. His College work should have been selected so that at the close of the year in the College he will have completed, either in entrance work or in College work, the following specified units of work (a unit is understood to mean one complete College entrance unit or five credit hours in the University):

4 units in Mathematics.
4 units in English.
4 units in Foreign Language.
1 unit in Physics.

If his work has not been selected to fulfill these requirements, the student will be required to make up all deficiencies.

WORK REQUIRED FOR GRADUATION.

The various courses of study outlined below are designed to give approximately the same amount of technical work as is given in the regular four-year courses of study. But the preceding year spent in College work enables the student to obtain a wider general education and to have a little greater freedom in the selection of some of his scientific and engineering studies. If in College the student has selected one or more of the courses that occur later in his engineering curriculum, he can secure a greater freedom in the selection of optional work to meet his individual needs.

Each course of study is designed to include 138 credit hours of work during the four years in the School of Engineering and two periods of summer work as indicated. In those courses, omitting one or two of the periods of summer work, the required credit hours to be completed in the regular school years are increased to 139 or 140 credit hours, respectively.

In the selection of his work in foreign language, the student is required to complete not less than five units of foreign language, of which at least two and three-fifths units must be in one modern language.

DEGREE GRANTED.

The degree of bachelor of science is granted upon the completion of one of the following courses of study, and the diploma given states the particular course of study pursued and the fact that this course of study is based upon one year's work in college.

CIVIL ENGINEERING.

(BASED ON ONE YEAR OF COLLEGE WORK.)

FRESHMAN YEAR.

First Semester, 16 credit hours.

Course Number.	*Subject.*	*Credit hrs.*
Mathematics 4 E	Analytic Geometry and Theory of Equations	5
German, French, or Spanish	Course as approved	5
Chemistry 2	Advanced Inorganic Chemistry	4
Mech. Drawing 1 and Mech. Drawing 2	Free-hand Drawing Mechanical Drawing	2

Second Semester, 17 credit hours.

Mathematics 5 E	Calculus I	5
German, French, or Spanish	Course as approved	3
Chemistry 3	Qualitative Analysis	4
Mech. Drawing 3	Descriptive Geometry	3
Mech. Drawing 4	Machine Drawing	2

SOPHOMORE YEAR.

First Semester, 17½ credit hours.

Civil Engineering 2	Surveying	2
Mathematics 6 E	Calculus II	3
Physics 1 E	General Physics	5
Geology 1	Elementary Geology	5
Shop Work 1 and Shop Work 2	Forging and Bench Work Woodworking and Molding	2
	Technical Report I‡	½

Second Semester, 18 credit hours.

Civil Engineering 2	Surveying	3
Civil Engineering 1	Topographical Drawing	2
English 50 E	Advanced Composition	3
Physics 2 E	General Physics	5
Mech. Engineering 5	Engines and Boilers	3
	Optional	2

Summer Work.

Civil Engineering 3	Field Work, 4 weeks.	

JUNIOR YEAR.

First Semester, 17½ credit hours.

Civil Engineering 50	Railway Drawing	1
Civil Engineering 58	Railway Surveying	5
Mechanics 50	Mechanics	5
	Optional	6
	Technical Report II‡	½

Second Semester, 16½ credit hours.

Civil Engineering 51	Graphical Statics	3
Civil Engineering 56	Roads and Pavements	2
Civil Engineering 57	Railway Location	3
Mechanics 51	Strength of Materials	4
Mechanics 52	Testing Laboratory	1
Economics 1	Elements of Economics	3
	Technical Report III‡	½

Summer Work.

Civil Engineering 53	Field Work, 4 weeks.	

SENIOR YEAR.

First Semester, 17½ credit hours.

Civil Engineering 55	Masonry	3
Civil Engineering 60	Hydraulic Laboratory	1
Civil Engineering 68	Hydraulics	3
Civil Engineering 61	Roofs and Bridges	5
Civil Engineering 59 or Elect. Engineering 60,	Sewerage and Water Supply Elements of Electrical Engineering	4
	Thesis‡	1
	Technical Report IV‡	½

Second Semester, 18 credit hours.

Civil Engineering 62	Bridge Design	5
Civil Engineering 52	Contracts and Specifications	3
Civil Engineering 54	Cement Laboratory	1
Civil Engineering 65	Reinforced Concrete	3
	Optional	4
	Thesis‡	2

MUNICIPAL AND SANITARY ENGINEERING.

(BASED ON ONE YEAR OF COLLEGE WORK.)

FRESHMAN YEAR.

The same as in Civil Engineering.

SOPHOMORE YEAR.

The same as in Civil Engineering.

JUNIOR YEAR.

First Semester, 16½ credit hours.

Course Number.	*Subject.*	*Credit hrs.*
Mechanics 50	Mechanics	5
Civil Engineering 59	Sewerage and Water Supply	4
Civil Engineering 67	Municipal Drawing	2
Chemistry 56 E	Water Analysis	5
	Technical Report II‡	½

Second Semester, 17½ credit hours.

Civil Engineering 56	Roads and Pavements	2
Civil Engineering 69	Sanitary Science	3
Civil Engineering 51	Graphical Statics	3
Civil Engineering 70	Sanitary Laboratory	1
Mechanics 51	Strength of Materials	4
Mechanics 52	Testing Laboratory	1
Economics 1	Elements of Economics	3
	Technical Report III‡	½

SENIOR YEAR.

First Semester, 18½ credit hours.

Civil Engineering 55	Masonry	3
Civil Engineering 60	Hydraulic Laboratory	1
Civil Engineering 61	Roofs and Bridges	5
Civil Engineering 68	Hydraulics	3
	Sanitary Journal	1
	Thesis‡	1
	Optional	4
	Technical Report IV‡	½

Second Semester, 18 credit hours.

Civil Engineering 52	Contracts and Specifications	3
Civil Engineering 64	Sanitary Design	5
Civil Engineering 65	Reinforced Concrete	3
Civil Engineering 54	Cement Laboratory	1
	Thesis‡	2
	Optional	3
	Sanitary Journal	1

ELECTRICAL ENGINEERING.

(BASED ON ONE YEAR OF COLLEGE WORK.)

FRESHMAN YEAR.

First Semester, 18 credit hours.

Course Number.	*Subject.*	*Credit hrs.*
Mathematics 4 E	Analytic Geometry and Theory of Equations	5
Chemistry 2	Advanced Inorganic Chemistry	4
German, French, or Spanish	Course as approved	5
Mech. Drawing 1 and Mech. Drawing 2	Free-hand Drawing Mechanical Drawing	2
Shop Work 1 and Shop Work 2	Forging and Bench Work Woodworking and Molding	2

Second Semester, 17 credit hours.

Mathematics 5 E	Calculus I	5
Chemistry 3	Qualitative Analysis	4
German, French, or Spanish	Course as approved	3
Mech. Drawing 3	Descriptive Geometry	3
Mech. Drawing 4	Machine Drawing	2

SOPHOMORE YEAR.

First Semester, 17½ credit hours.

Physics 1 E	General Physics	5
Mathematics 6 E	Calculus II	3
Chemistry 64	Physical Chemistry	5
Civil Engineering 2	Surveying	3
Mech. Engineering 1	Machine Drafting	1
	Technical Report I‡	½

Second Semester, 17½ credit hours.

Mathematics	Course to be elected	3
Physics 2 E	General Physics	5
Mech. Engineering 3	Elementary Machine Design	3
Mech. Engineering 4	Steam Machinery	2
Economics 1	Elements of Economics	3
Shop Work 3	Pattern Making	1
	Technical Report II‡	½

Summer Work.

Shop Work, 4 weeks, 44 hours per week.

JUNIOR YEAR.

First Semester, 17½ credit hours.

Elect. Engineering 50	Dynamo Machinery	3
Elect. Engineering 54	Electrical Laboratory	1½
Mechanics 50	Mechanics	5
Physics 52	Theory of Electricity	3
Physics 60 E	Electrical Measurements I	1½
Mech. Engineering 52	Heat Engine Theory	3
	Technical Report III‡	½

Second Semester, 18 credit hours.

Elect. Engineering 51	Theory of Alternating Currents	5
Elect. Engineering 55	Electrical Laboratory	1½
Mech. Engineering 53	Mechanics of the Steam Engine	2
Mechanics 51	Strength of Materials	4
Mechanics 52	Testing Laboratory	1
English 50 E	Advanced Composition	3
Physics 61	Electrical Measurements II	1½

SENIOR YEAR.

First Semester, 16 credit hours.

Elect. Engineering 52 ..	Advanced Dynamo Machinery....	5
Elect. Engineering 56 ..	Advanced Electrical Laboratory..	1½
Mech. Engineering 65 ..	Heat Engine Laboratory........	2
	Thesis‡	1
	Optional	6
	Technical Report IV‡..........	½

Second Semester, 17 credit hours.

Elect. Engineering 57 ..	Electric Lighting	3
Elect. Engineering 58 ..	Electric Power Transmission.....	5
Civil Engineering 52 ...	Contracts and Specifications.....	3
	Optional	3
	Thesis‡	3

One extended inspection trip is required during the Junior or the Senior year. (See page 261.)

MECHANICAL ENGINEERING.

(BASED ON ONE YEAR OF COLLEGE WORK.)

FRESHMAN YEAR.

First Semester, 17 credit hours.

Course Number.	*Subject.*	*Credit hrs.*
Mathematics 4 E	Analytic Geometry and Theory of Equations	5
Chemistry 2	Advanced Inorganic Chemistry..	5
German, French, or Spanish	Course as approved	5
Mech. Drawing 1	Free-hand Drawing	1⅓
Mech. Drawing 2	Mechanical Drawing	⅔

Second Semester, 17 credit hours.

Mathematics 5 E	Calculus I	5
Chemistry	Optional	5 or 3
	College Optional	3 or 5
Mech. Drawing 4	Machine Drawing..............	2
Shop Work 1 and Shop Work 2.......	Forging and Bench Work Woodworking and Molding..	2

SOPHOMORE YEAR.

First Semester, 17½ credit hours.

Mathematics 6 E	Calculus II	3
Physics 1 E	General Physics	5
Mech. Drawing 3	Descriptive Geometry	3
Shop Work 3 and Shop Work 4 and Shop Work 5.......	Pattern Making and Founding Forging, Filing, Bench Work Lathe Work	3
Mech. Engineering 2 ...	Mechanism	3
	Technical Report I‡...........	½

Second Semester, 17½ credit hours.

	Optional	3
Physics 2 E	General Physics	5
Mech. Engineering 6	Steam Engineering	4
Mechanics 50	Mechanics	5
	Technical Report II‡	½

JUNIOR YEAR.

First Semester, 17½ credit hours.

Mechanics 51	Strength of Materials	4
Mechanics 52	Testing Laboratory	1
Mech. Engineering 51	Thermodynamics	4
Mech. Engineering 64	Mechanical Laboratory	1
Metallurgy 61 E	Metallurgy I	3
	Optional	3
Shop Work 6	Lathe and Machine Tool Work	1
	Technical Report III‡	½

Second Semester, 17 credit hours.

Mech. Engineering 50	Machine Design	4
Mech. Engineering 54	Heating and Ventilation	2
Mech. Engineering 69	Shop Administration	2
English 50 E	Advanced Composition	3
Economics 1	Elements of Economics	3
Mech. Engineering 65	Heat and Engine Laboratory	2
Shop Work 7	Tool Making	1

Summer Work.

Shop Work, 4 weeks, 44 hours per week; or, commercial work.

SENIOR YEAR.

First Semester, 18 credit hours.

Mech. Engineering 56	Steam Engine Design	2
Mech. Engineering 67	Thesis	1
Civil Engineering 68	Hydraulics	3
Civil Engineering 60	Hydraulic Laboratory	1
Civil Engineering 71	Surveying	3
Elect. Engineering 50	Dynamo Machinery	3
Elect. Engineering 54	Electrical Laboratory	1½
	Technical Report IV‡	½
OPTIONAL.		
Mech. Engineering 61	Structual Design	3
Mech. Engineering 58	Gas Engine Design	
Mech. Engineering 60	Hydraulic Design	
Mech. Engineering 55	Refrigeration	

Second Semester, 16½ credit hours.

Mech. Engineering 67	Thesis	2
Mech. Engineering 69	Works Management	2
Civil Engineering 52	Contracts and Specifications	3
Elect. Engineering 51	Alternating Currents	3
Elect. Engineering 55	Electrical Laboratory	1½
OPTIONAL.		
Mech. Engineering 57	Steam Turbine Design	5
Mech. Engineering 59	Gas Engine Design II	
Mech. Engineering 62	Industrial Plant Design	
	Other approved Engineering subject	

MINING ENGINEERING.

(BASED ON ONE YEAR OF COLLEGE WORK.)

FRESHMAN YEAR.

First Semester, 16 credit hours.

Course Number.	*Subject.*	*Credit hrs.*
German, French, or Spanish	Course as approved	5
Mathematics 4 E	Analytic Geometry and Theory of Equations	5
	Optional	2
Mech. Drawing 1	Free-hand Drawing	1⅓
Mech. Drawing 2	Mechanical Drawing	⅔
Mech. Drawing 4 or	Machine Drawing	2
Shop Work 1 and	Forging and Bench Work	
Shop Work 2	Woodworking and Molding	

Second Semester, 18 credit hours.

Mathematics 5 E	Calculus I	5
German, French, or Spanish	Course as approved or Optional	3
Mech. Drawing 3	Descriptive Geometry	3
Geology 1	Elementary Geology	5
Mech. Drawing 4 or	Machine Drawing	2
Shop Work 1 and	Forging and Bench Work	
Shop Work 2	Woodworking and Molding	

SOPHOMORE YEAR.

First Semester, 17½ credit hours.

Mineralogy 1 E	Elementary Mineralogy I	5
Civil Engineering 2	Surveying	2
Physics 1 E	General Physics	5
Chemistry 2	Advanced Inorganic Chemistry	4
Mech. Engineering 1	Machine Drafting	1
	Technical Report I‡	½
	Mining Journal	

Second Semester, 17½ credit hours.

Mining Engineering 60	Mining Drawing	1
Civil Engineering 2	Surveying	3
Physics 2 E	General Physics	5
Chemistry 3	Qualitative Analysis	4
Economics 1	Elements of Economics	3
Shop Work 4	Forging, Filing and Bench Work,	1

Summer Work.

Civil Engineering 3	Field Work, 4 weeks.

JUNIOR YEAR.

First Semester, 18½ credit hours.

Mining Engineering 50	Mining	5
Mechanics 50	Mechanics	5
Geology 52	Economic Geology I	3
Chemistry 54	Quantitative Analysis I	5
	Technical Report III‡	½
	Mining Journal	

Second Semester, 17½ (or 18½) credit hours.

Mineralogy 62 E	Petrography	5
Metallurgy 57	Assaying	5
Geology 53	Economic Geology II	2
Mining Engineering 57	Mining Law	(-)1
Mechanics 51	Strength of Materials	4
Mechanics 52	Testing Laboratory	1
	Technical Report IV‡	½
	Mining Journal	

Summer Work.

Mining Engineering 59	Field Work.

SENIOR YEAR.

First Semester, 17 credit hours.

Mining Engineering 51	Ore dressing	3
Mining Engineering 52	Power, Extraction, etc.	5
English 50 E	Advanced Composition	3
Mining Engineering 58	Thesis	1
	Optional	5
	Mining Journal	

Second Semester, 15½ (or 16½) credit hours.

Mining Engineering 51	Ore Dressing	3
Mining Engineering 53	Sampling and Exploitation	2½
Civil Engineering 52	Contracts and Specifications	3
Mining Engineering 58	Thesis	2
Metallurgy 62 E	Metallurgy II	5
Mining Engineering 57	Mining Law	(-)1

CHEMICAL ENGINEERING.

(BASED ON ONE YEAR OF COLLEGE WORK.)

NOTE.—Students planning to take the four-year advanced course of study in chemical engineering are very strongly advised to elect chemistry 1 as part of their College work, in addition to the work already recommended in the statement preceding these advanced courses.

FRESHMAN YEAR.

First Semester, 17 credit hours.

Course Number.	*Subject.*	*Credit hrs.*
Chemistry 2	Advanced Inorganic Chemistry	5
Mathematics 4 E	Analytic Geometry and Theory of Equations	5
	Optional	5
Mech. Drawing 1 and Mech. Drawing 2	Free-hand Drawing Mechanical Drawing	2

Second Semester, 17 credit hours.

Course Number.	*Subject.*	*Credit hrs.*
Chemistry 3	Qualitative Analysis	5
Mathematics 5 E	Calculus I	5
Mech. Drawing 3	Descriptive Geometry	3
Mech. Drawing 4	Machine Drawing	2
Shop Work 1 Shop Work 2	Forging and Bench Work Woodworking and Molding	2

SOPHOMORE YEAR.

First Semester, 17½ credit hours.

Course Number.	*Subject.*	*Credit hrs.*
Chemistry 54	Quantitative Analysis I	5
Physics 1 E	General Physics	5
Mechanics 50	Mechanics	5
Shop Work 4 (modified),	Bench and Lathe Work	1
Mech. Engineering 1	Machine Drafting	1
	Technical Report I‡	½

Second Semester, 18½ credit hours.

Course Number.	*Subject.*	*Credit hrs.*
Chemistry 55	Quantitative Analysis II	5
Physics 2 E	General Physics	5
Mechanics 51	Strength of Materials	4
Mechanics 52	Testing Laboratory	1
Mech. Engineering 3 or Mech. Engineering 5	Machine Design Engines and Boilers	3
	Technical Report II‡	½

JUNIOR YEAR.

First Semester, 18½ credit hours.

Course Number.	*Subject.*	*Credit hrs.*
Chemistry 4	Organic Chemistry I	5
Metallurgy 61 E	Metallurgy I	3
Geology 1	Elementary Geology	5
English 50 E	Advanced Composition	3
	Optional	2
	Technical Report III‡	½

Second Semester, 18½ credit hours.

Chemistry 60	Organic Chemistry II	5
Chemistry 51 A	Inorganic Industrial Chemistry	3
Metallurgy 62 E	Metallurgy II	3
Mineralogy 1 E	Elementary Mineralogy I	5
	Optional	2
	Technical Report IV‡	½

SENIOR YEAR.

First Semester, 16 credit hours.

Chemistry 51 B	Industrial Organic Chemistry	2
Chemistry 64	Physical Chemistry	5
Chemistry	Optional	5
	Optional	2
	Thesis‡	2

Second Semester, 17 credit hours.

Chemistry 65	Physical Chemistry	5
Metallurgy 57	Assaying	3
Civil Engineering 52	Contracts and Specifications	3
Economics 1	Elements of Economics	3
	Thesis‡	3

ARCHITECTURAL ENGINEERING.

(BASED ON ONE YEAR OF COLLEGE WORK.)

FRESHMAN YEAR.

First Semester, 18 credit hours.

Course Number.	*Subject.*	*Credit hrs.*
Mathematics 4 E	Analytic Geometry and Theory of Equations	5
German, French, or Spanish	Course as approved	5
Chemistry 2	Advanced Inorganic Chemistry	4
Arch. Engineering 1	Free-hand Drawing	2
Mech. Drawing 2 (modified)	Mechanical Drawing	2

Second Semester, 17 credit hours.

Mathematics 5 E	Calculus I	5
German, French, or Spanish	Course as approved, or Optional	3
Chemistry 3	Qualitative Analysis	4
Mech. Drawing 3	Descriptive Geometry	3
Arch. Engineering 2	Architectural Drawing	2

SOPHOMORE YEAR.

First Semester, 17½ credit hours.

Arch. Engineering 3	Architectural Design I..........	3
Arch. Engineering 5	History of Architecture I.......	2
Physics 1 E	General Physics	5
Mathematics 6 E	Calculus II	3
Civil Engineering 2	Surveying	2
Shop Work 1 and Shop Work 2.......	Forging and Bench Work... Woodworking and Molding..	2
	Technical Report I‡............	½

Second Semester, 18 credit hours.

Arch. Engineering 4	Architectural Design II.........	3
Arch. Engineering 6	History of Architecture II......	2
Physics 2 E	General Physics	5
Mech. Engineering 5 ...	Engines and Boilers............	3
English 50 E	Advanced Composition	3
	Optional	2

JUNIOR YEAR.

First Semester, 17½ credit hours.

Arch. Engineering 7	Architectural Design III........	3
Mechanics 50	Mechanics	5
Elect. Engineering 64 ..	Elec. Engineering for Architects,	3
	Optional	6
	Technical Report II‡...........	½

Second Semester, 16½ credit hours.

Arch. Engineering 8	Architectural Design IV........	3
Arch. Engineering 10 ...	Sanitary Construction	2
Mechanics 51	Strength of Materials	4
Mechanics 52	Testing Laboratory	1
Economics 1	Elements of Economics.........	3
Civil Engineering 51 ...	Graphical Statics	3
	Technical Report III‡..........	½

SENIOR YEAR.

First Semester, 17½ credit hours.

Arch. Engineering 11 ...	Architectural Engineering I.....	4
Civil Engineering 55 ...	Masonry	3
Civil Engineering 68 ...	Hydraulics	3
Civil Engineering 60 ...	Hydraulic Laboratory	1
Civil Engineering 61 ...	Roofs and Bridges..............	5
	Thesis	1
	Technical Report IV‡...........	½

Second Semester, 18 credit hours.

Arch. Engineering 9	Steel Construction	3
Arch. Engineering 12 ...	Architectural Engineering II....	4
Civil Engineering 52 ...	Contracts and Specifications....	3
Civil Engineering 54 ...	Cement Laboratory	1
Civil Engineering 65 ...	Reinforced Concrete	3
Mech. Engineering 54 ...	Heating and Ventilation........	2
	Thesis	2

EQUIPMENT.

The School of Engineering is part of the general University, hence the entire equipment of the University is also equipment of the School of Engineering in all things in which engineering students are concerned. The work of the Engineering School which is common to several schools of the University, such as mathematics, physics, chemistry, languages, etc., is carried on to some extent in buildings and by departments of instruction not exclusively for engineering students; while such work of the School as is technical and exclusively engineering in character is carried on by departments of instruction primarily for engineering students and largely in buildings erected for the special work of the School. Below is described that part of the general equipment of the University which pertains chiefly to the work of this School. For other equipment, see under "The College" and descriptions of other schools of the University.

BUILDINGS.

The buildings erected exclusively for engineering work are Marvin Hall, the mechanical laboratory in connection with the power plant, and the Fowler Shops. The work in mining is provided for in Haworth Hall. For description of these buildings, see under the heading "Buildings and Grounds."

LIBRARIES.

The general University library is available for the use of engineering students. Collections of books for special use in connection with the studies in the various scientific and technical departments are to be found in the reading rooms of the departmental libraries of Marvin Hall and other buildings. The leading technical journals are also to be found in these reading rooms.

DRAWING ROOMS.

In Marvin Hall there are six large, well-lighted drawing rooms, provided with individual tables containing drawers for each student's outfit and cabinets for drawing boards.

On the walls and contained in various print-cases are photographs of actual constructions, and large numbers of blue prints of working drawings for bridges, railway structures, sewers, waterworks, power and light stations, mine plants, etc.

LABORATORIES.

Numerous and well-equipped laboratories are provided for experimental work in engineering and scientific studies. These laboratories and equipments are described in detail under the descriptions of the various engineering courses and scientific departments.

CIVIL AND MUNICIPAL ENGINEERING.

The instruments for field work in civil engineering comprise transits, levels, compasses, solar attachments, rods, chains, tapes, plane tables, heliotropes, current meter, aneroids, and other minor instruments. Among these are a precise level for very accurate leveling, a secondary triangulation transit for topographical work, and an altazimuth instrument for use on primary triangulations, which has a ten-inch circle, read to single seconds of arc.

For the summer work in surveying a complete camping outfit is provided. Planimeters, Thatcher and Manheim slide rules, and Colby's stadia slide rules are used for rapid calculation and estimation of quantities.

The cement laboratory affords facilities for extended investigation work as well as for the current undergraduate courses.

The road-materials laboratory contains various machines for testing the strength, resistance to abrasion, and the cementing power of the dust of stone, the value of which as material for the building of rock roads is under investigation.

The sanitary laboratory is equipped with apparatus for the investigation of water and sewage. It is not designed to supplant the chemical laboratories, but to afford means for making approximate and quick analyses for engineering purposes of samples suspected of contamination. The laboratory is also to be used in connection with research work along sanitary lines, in connection with an experimental plant for the treatment of the sewage from some of the University buildings.

MECHANICS AND HYDRAULICS.

The testing-of-materials laboratory, situated in the basement of Marvin Hall, is equipped for making tests on all kinds of structural materials.

The principal machines are a 200,000-pound Olsen universal testing machine capable of testing beams up to twenty feet in length and columns up to ten feet in height; two 100,000-pound and one 40,000-pound universal testing machines; a 50,000-inch-pound Olsen torsion machine; a White-Souther alternate-stress machine, and a standard rattler for testing paving brick. The laboratory is well equipped with small apparatus, such as extensometers, both direct-reading and autographic, compressometers, etc.

The concrete laboratory is provided with mixing machinery, molds for making test pieces, and apparatus for the mechanical analysis of sands and cements.

The hydraulic laboratory contains a measuring pit, a large steel orifice tank for experimentation with jets, a triplex power pump, two centrifugal pumps, pipe lines, weir boxes, gauges, a Venturi meter with manometer, a Pelton water mortor, etc., arranged to illustrate the laws of fluid motion, and affording some opportunity for testing hydraulic machinery.

ELECTRICAL ENGINEERING.

The electrical engineering laboratories are situated in Marvin Hall and comprise a dynamo laboratory, a standardizing laboratory, a photometer room, and space for the telephone equipment.

The dynamo laboratory is fitted with a complete line of both alternating and direct-current machines, the former varying in capacity from a two-horsepower motor to a 50-kilowatt generator, while the direct-current machines range in capacity from one and one-half kilowatts to 20 kilowatts. These machines have been selected essentially with the view of supplying a complete set of experimental machines and to illustrate modern design and practice in dynamo-electric machinery. Individual motor drive is used for all experimental work, and a chain hoist and trolley have been provided for use in quickly moving any of the machines to the position in which they may be required. Very few permanent connections are used, but the switchboards, connecting boards, and testing tables have all been especially designed to facilitate the connection of any piece of apparatus to a proper power supply. Direct current is supplied from the University power plant, but all other voltage supply is through the agency of motor-generator sets in the laboratory. The machines in this room are used also as sources of current supply for the other electrical laboratories. The assortment of field and load rheostats, transformers, reactance coils, etc., is adequate.

In the standardizing laboratory provision is made for the calibration of all types of electrical measuring instruments and for the study of problems in electrical measurements. The equipment consists of a potentiometer, an A. C. - D. C. comparator; laboratory standard ammeters, voltmeters, and wattmeters; a precise Wheatstone bridge; a portable testing set; an inductance bridge; and a three-element oscillograph. These instruments are all equipped with a complete set of auxilliaries such that any ordinary range of potential or current in either direct or alternating currents may be measured. A storage battery is provided as a source of steady current for use in calibrating instruments. The portable instruments used in the dynamo laboratory are cared for in the standardizing room. This set of instruments is very complete and includes the best of foreign as well as American manufacture. In addition to the instruments in regular use this set contains portable meters of suitable types and ranges for the tests of power plants or of machines in regular commercial operation.

The photometer room is fitted with a 300-centimeter photometer bar, which is provided with necessary lamp holders and auxiliaries for the testing of the different types of lamps used in artificial illumination. A Bunsen screen, a Lummer-Brodum screen, and a flicker photometer have been provided for use in connection with this bar. A portable photometer of the Sharp-Miller type is used for studying the illumination of streets and buildings.

The telephone laboratory has an assortment of modern telephone apparatus. This includes complete sets for illustrating installations, of both local battery and central energy types. The best selective systems are represented, as well as a complete small automatic telephone system.

MECHANICAL ENGINEERING.

The mechanical laboratory is a room 48 by 100 feet, with a gallery 16 feet wide extending across one end and along one side about 60 feet. On the gallery floor are office, computing room, storeroom, instrument room, oil room fitted up with special apparatus for testing lubricants, and a fuel-testing room equipped with a Mahler bomb calorimeter, a Parr calorimeter, and apparatus for coal and gas analysis.

On the main floor are installed a 100-horsepower experimental boiler of Stirling water-tube type; an independently fired Foster superheater; a 10 by 24 by 30-inch cross-compound Monarch Corliss steam engine, arranged to belt to a 55-kw. direct-current generator; a 75-horsepower Ball automatic high-speed engine; a 20-horsepower De Laval steam turbine coupled to a centrifugal pump used for circulating water for the condenser; a 10-horsepower Atlas slide-valve engine; a C. H. Wheeler surface condenser of 600 square feet surface, equipped with wet and dry vacuum pumps; a 100-horsepower two-cylinder tandem Riverside gas engine direct-connected to the 55-kw. generator above mentioned; two 8-horsepower gas or gasoline engines; a 75-horsepower Smith suction gas producer; a five-ton Cleveland ammonia compressor, motor driven, with submerged condenser and fittings complete, including a small ice box (can system), and an auxiliary brine cooler; several special lubricant-testing machines; a complete air-brake outfit for train service; and other minor pieces of apparatus. A representative outfit of engine indicators, steam calorimeters, etc., is owned by the department.

MINING ENGINEERING.

The building for geology and mining (Haworth Hall) was so planned as to give excellent opportunity for the concentration of ores. The ore-dressing laboratory, 40 by 80 feet, is connected to the main building by a corridor, and is so placed on a slope that the floor is divided into four steps, allowing ore to be carried from one floor to the other by gravity. The equipment consists of crushing, screening, and classifying apparatus of various kinds, giving practice in all of the principal processes of ore dressing. There has recently been added a coal-washing plant for experimental work on a large scale. The mining museum contains models of mines and a collection of mills and apparatus used in mining and milling operations. A large laboratory has been equipped for making a thorough and complete examination of the clays of Kansas.

CHEMICAL ENGINEERING.

The chemical laboratories are located in the Chemistry and Pharmacy Building. They contain separate rooms for general chemistry, qualitative analysis, quantitative analysis, organic chemistry, physical chemistry, water analysis, food analysis, assaying, and metallurgy. Dispensing and balance rooms and the offices of the instructors are conveniently located about the building. There are several lecture and recitation rooms, the largest seating more than three hundred students. There is also a departmental library, containing sets of the principal chemical journals, as well as carefully selected reference books upon the subject. The department is well supplied with all the necessary and usual apparatus for lecture illustration and demonstration, for laboratory work in all the undergraduate courses, together with adequate equipment for effective graduate and research work in analytical, organic, physical, industrial, and metallurgical chemistry. A somewhat unusual piece of equipment is a well-working liquid-air plant, which affords excellent opportunity for work at low temperatures.

THE FOWLER SHOPS.

The equipment of the shops is selected with a view to its being the means of teaching modern methods of machine construction, rather than to develop individual skill. The order of progress of the student through the various departments is consistent with the same idea.

In producing castings for machines the first step of pattern making is provided for, in a room 50 by 80 feet on the second floor, by benches and bench tools of high class, sufficient for a class of eighteen in a single section; twelve Richardson 11 by 28-inch speed-lathes with full tool equipment; a complete patternmaker's lathe, 18 in. by 12 ft., and a 7-foot faceplate lathe; a combination table saw, an Oliver band saw, and a scroll saw; a power-driven boring machine and a sandpapering machine, motor-driven group system; and special hand tools to facilitate accurate and rapid work. The second step—that of the actual casting—is provided for by foundry equipment in a room 60 by 66 feet, consisting of a Whiting melting cupola of one and one-half tons capacity per hour; a brass furnace complete; an automatic molding machine; a core machine and full equipment for core work; and all necessary hand tools for work in a molding room, arranged in typical modern fashion. An elevator to the cupola-charging platform, and a geared tumbler and a grinder for cleaning castings, are included.

For preparing wrought metals, and for making cutting tools, the forge shop, 40 by 50 feet, is equipped with sixteen Sturtevant down-draft forges and one large forge for heavy work, with a full complement of smithing tools, a Little Giant power hammer to facilitate rapid work and to familiarize students with its use.

For the final work of machine construction, the machine shop, a room 50 by 80 feet, is supplied with fourteen 14 in. by 6 ft. Standard engine lathes; one 18 in. by 12 ft. and one 14 in. by 5 ft. Challenge engine lathes with full attachments; one Jones and Lawson 2 in. by 24 in. turret lathe with chucking attachments; one 26 in. by 26 in. by 7 ft. Gray planer; one Universal milling machine with spiral gear cutter and all attachments; a Lucas No. 21 precision horizontal boring, drilling and milling machine, with individual motor; one 15 in. crank shaper; one 25 in. Challenge drill press with automatic feed; three 20 in. drill presses; one sensitive drill press; one 1½ in. bolt cutter; one Universal cutter and reamer grinder; one Yankee drill grinder; and other power dry and wet grinders, etc. The room has 160 feet of benches with twenty vises and a good outfit of hand tools, which, with stock and supplies, are kept in a tool room under the care of a skilled attendant, the students being held to a rigid observance of shop rules. Electric-motor drive by the group system is used throughout the shop.

THE POWER PLANT.

The power plant is in the same building with the mechanical engineering laboratory, and is designed for the double purpose of furnishing light and power to the entire University and of giving engineering students an opportunity to study power costs with modern equipment.

The boiler-room equipment consists of two 150-horsepower Bonus-Kennicott water-tube boilers, equipped with Jones underfeed stokers; a Sturtevant economizer; and an induced-draft system with motor-driven fan. A pressure of 150 pounds is carried. All feed water is metered with a Worthington piston meter, and coal-weighing scales are provided.

In the generator room is a 150-kw. 115-230 volt three-wire direct-current Western Electric Generator, direct-connected to an 11 in. by 19 in. by 16 in. cross-compound Ball engine making 225 revolutions per minute; a 100-kw. 2300-volt, three-phase 60-cycle Curtis turbo-alternator built by the General Electric Company; a 75-kw. motor-generator set for alternating-current and direct-current, with synchronous motor, by means of which both forms of current may be delivered with one steam machine in operation; one 8 in. by 12 in. by 7 in. by 12 in. compound duplex Advance service pump for the general water supply of the University and one large high-pressure Underwriter's pump for fire protection.

All the main engines and pumps exhaust into one 1200 sq. ft. surface condenser equipped with both wet and dry vacuum pumps for high-vacuum service and a centrifugal circulating pump. All pumps are motor driven. Crane pipe and fittings have been used throughout the plant.

The switchboard is of General Electric design, and is fully appointed, with complete outfit of recording and indicating meters. Six single-phase lighting circuits, one three-phase power circuit, and three three-wire direct-current power circuits supply the University buildings through an underground conduit system installed by the Standard Underground Cable Company.

DESCRIPTION OF COURSES.

Courses that are given in only the first half of a semester are indicated by (*a*); those given in the second half of a semester by (*b*). The statement of "hours" refers to the number of hours per week in attendance at class. The value of each course is given in "credits," one credit being equivalent to one hour per week of recitation or lecture carried for a semester. (See "The Course and the Credit Hour" page 206.)

ARCHITECTURAL ENGINEERING.

Professor GRIFFITH.
Associate Professor H. A. RICE.
Associate Professor ——————.

1.—FREE-HAND DRAWING. Charcoal and pencil drawing from the cast. Six hours, two credits, first semester. Griffith.

2.—ARCHITECTURAL DRAWING. Theory of perspective, free-hand perspective, shades and shadows. Six hours, two credits second semester. Griffith.

3.—ARCHITECTURAL DESIGN I. Planning, detailing, working drawings, and detailed sketching from work in course of construction. Nine hours, three credits, first semester. ———.

4.—ARCHITECTURAL DESIGN II. Continuation of course 3, with especial reference to materials used in construction, brick, stone, wood, terra-cotta, cast iron, steel, and the detailing of materials as used in buildings. Nine hours, three credits, second semester. ———.

5.—HISTORY OF ARCHITECTURE I. This course will take up the architecture of Egypt, Assyria, Greece, and Rome, and will include a study of the materials used as well as of the methods of planning and design. Two credits, first semester. ———.

6.—HISTORY OF ARCHITECTURE II. A continuation of course 5 to include the Romanesque, Gothic, and Renaissance. It will also include the architecture of the United States. Two credits, second semester. ———.

7.—ARCHITECTURAL DESIGN III. A study and analysis of examples of classical architecture, designed to train the student in the esthetics of architecture and make clear the fundamentals of architectural design. In this course practice in designing and rendering will be given. Three credits, first semester. ———.

8.—ARCHITECTURAL DESIGN IV. Architectural loads, foundations, building laws, fireproofing, and specifications. Three credits, second semester. ———.

9.—STEEL CONSTRUCTION. A course in mill building, designed with especial reference to trusses, columns and crane girders. Three credits, second semester. H. A. Rice.

10.—SANITARY CONSTRUCTION. Plumbing, sewerage, water and its purification. A course of lectures on general health problems will be given. Two credits, second semester. ———.

11.—ARCHITECTURAL ENGINEERING I. Detailing and designing in timber construction, with lectures on timber cutting, growth and seasoning. Four credits, first semester. ———.

12.—ARCHITECTURAL ENGINEERING II. Steel building design, with details. The second half of the semester will be devoted to reinforced concrete design, floors, columns and girders. Four credits, second semester. ———.

BACTERIOLOGY.

Professor BILLINGS.
Assistant Professor C. C. YOUNG.

53E.—SANITARY WATER ANALYSIS. (See chemistry 56E.) Open to students in engineering and to College Juniors and Seniors who have taken chemistry 3. Part of the semester will be devoted to bacteriological technic and reading along general lines, followed by special work on the bacteriology of water and sewage. The remainder of the semester will be spent in chemical quantitative analysis of water and sewage and interpretation of results of sanitary tests. Both semesters, 10 hours, daily, 8 to 10. Five credits. C. C. Young.

For other courses in bacteriology, see The College.

CHEMISTRY.

Professor E. H. S. BAILEY,
Professor CADY.
Associate Professor DAINS.
Associate Professor WHITAKER
Assistant Professor ALLEN.
Assistant Professor C. C. YOUNG.
Mr. RODEBUSH, Instructor.

2.—ADVANCED INORGANIC CHEMISTRY. Required of Sophomores, first semester. For all but chemical engineering students, lectures and recitations on Monday, Wednesday, and Friday, at 8; laboratory two hours, Tuesday or Thursday, 8 to 10 or 1:30 to 3:30; total of four credits. For chemical engineering students, lectures and recitations on Monday, Wednesday, and Friday, at 8; laboratory four hours, Tuesday and Thursday, 8 to 10 or 1:30 to 3:30; total of five credits. Cady and assistants.

3.—QUALITATIVE ANALYSIS. Required of Sophomores, second semester. For all but chemical engineering students, recitations on Tuesday and Thursday, at 8; laboratory four hours, Monday and Wednesday or Wednesday and Friday, 8 to 10 or 1:30 to 3:30; total of four credits. For chemical engineering students, recitations on Tuesday and Thursday at 8; laboratory six hours, Monday, Wednesday, and Friday, 8 to 10 or 1:30 to 3:30; total of five credits. Cady and assistants.

4.—ORGANIC CHEMISTRY I. Required of chemical engineering students. Lectures, recitations, and laboratory work in aliphatic series. Must be preceded by courses 2 and 3. Junior, first semester, seven hours; lecture and recitations, Monday, Wednesday, and Friday; laboratory Tuesday and Thursday, 1:30 to 3:30. Five credits. Dains.

5E.—ENGINEERING CHEMISTRY. Required of mechanical and civil engineering students, second semester. Recitations Tuesday and Thursday, at 9; laboratory Friday, 1:30 to 4:30. Cady and assistants.

50E.—GAS ANALYSIS. A laboratory course in the quantitative determination of the common gases, analysis of gaseous mixtures, natural gas, flue gases, etc. Must be preceded by course 54. Optional, first semester, four hours, by appointment. Two credits. Allen.

51A.—INORGANIC INDUSTRIAL CHEMISTRY. Required of Junior chemical engineering students. Three hours, second semester, at 11:15. A study of the inorganic industries, including such topics as the manufacture of acids, alkalies and other chemicals, fertilizers, paints and pigments, glass and cement and the purification of water. Prerequisites, courses 1, 2, 3. Whitaker.

51B.—ORGANIC INDUSTRIAL CHEMISTRY. Required of Senior chemical engineering students. Two hours, first semester, at 9. A study of the organic industries, including such topics as the refining of petroleum, the distillation of wood and coal, packing houses, fermentation, soaps, leather, paper, starches, sugars, dyestuffs, etc. Prerequisite, courses 1, 2, 3, 4. Whitaker.

52E.—ELECTROLYTIC ESTIMATION OF METALS. A laboratory course. Must be preceded by course 54. Optional, second semester, four hours, by appointment. Two credits. Allen.

53E.—ANALYSIS OF BOILER FEED WATER. Must be preceded by course 54. Optional, first semester, four hours, by appointment. Two credits. C. C. Young.

54.—QUANTITATIVE ANALYSIS I. Lecture and laboratory work. Must be preceded by course 3. Required of chemical and mining engineering students. Both semesters. First semester, ten hours, 10:25 to 12:15 or 3:30 to 5:30; second semester, ten hours, 10:25 to 12:15. Five credits. Allen and assistants.

55.—QUANTITATIVE ANALYSIS II. Lecture and laboratory work. Required of chemical engineering students. In the latter part of the course the volumetric analysis of ores and metallurgical products will be taken up. Second semester, ten hours, 1:30 to 3:30. Five credits. Allen and assistants.

56E.—SANITARY WATER ANALYSIS. (See bacteriology 53E.) Open to students in engineering and to College Juniors and Seniors who have taken chemistry 3. Part of the semester will be devoted to bacteriological technic and reading along general lines, followed by special work on the bacteriology of water and sewage. The remainder of the semester will be spent in chemical quantitative analysis of water and sewage and interpretation of results of sanitary tests. Both semesters, 10 hours, daily, 8 to 10. Five credits. C. C. Young.

59.—WATER ANALYSIS. Three hours, second semester, by appointment. Laboratory work and conferences upon assigned readings. The course covers sanitary, mineral and boiler feed water analysis, together with the principles and practice of the purification of water for municipal and other uses. Prerequisite, course 54. C. C. Young.

60.—ORGANIC CHEMISTRY II. A continuation of course 4. Lectures, recitations, and laboratory work, including the aromatic and other cyclic compounds. Must be preceded by course 4. Required of chemical engineering students. Junior, second semester, seven hours, 3:30 to 5:30. Five credits. Dains.

64.—PHYSICAL CHEMISTRY. A course paying special attention to electrochemistry. Lectures and laboratory work. Must be preceded by course 54, or by course 3 and physics 1E and 2E and mathematics 7. Required of chemical and electrical engineering students; optional for mining engineers. First semester, six hours, at 10:15. Five credits. Cady.

65.—PHYSICAL CHEMISTRY. A general course in theoretical and physical chemistry. Lectures and laboratory work. Required of chemical engineering students. Second semester, seven hours, at 10:25. Five credits. Cady.

Other courses in chemistry are open as optionals to chemical engineering students. See The College.

CIVIL AND MUNICIPAL ENGINEERING.

Dean MARVIN.
Professor DALTON.
Professor G. W. JONES.
Professor H. A. RICE.
Assistant Professor STRADLING.
Assistant Professor ————.
Mr. J. O. JONES, Instructor.

1.—TOPOGRAPHICAL DRAWING. A study of and practice in the conventional methods of representing topography, coupled with the platting of the results of field practice in connection with surveying. Required of Sophomore civil and mining engineering students, second semester, six hours, Monday and Wednesday, or Thursday and Friday, 1:30 to 4:30. Two credits. Stradling.

2.—SURVEYING. Engineer's instruments, their construction and adjustment. Methods of marking and platting land, topographic, mining, and hydrographic surveys. Sources of error and means of controlling the precision of field work. Leveling and earthwork. Required of civil and mining engineering students. Sophomore, first semester, two hours, at 8 or 10:15, two credits, and second semester, two hours, 10:25 or 11:25, and field practice once a week. Three credits. Dalton, Stradling.

3 or 53.—SUMMER FIELD WORK. Courses in practical surveying. The character of the work done will vary somewhat from year to year, depending upon the make-up of the body of students that go into camp. Ten hours per day for four weeks, at the close of the college year, in June. Dalton and assistants.

50.—RAILWAY DRAWING. Railway plats, profiles, and plans for track and small structures. Lectures and drawing-room practice in tracing and blue-printing and in platting the results of field work. Junior, first semester, three hours, Tuesday, 1:30 to 4:30. One credit. Stradling.

52.—CONTRACTS AND SPECIFICATIONS. An elementary course in the law of contracts, with special reference to engineering practice. The technical features of specifications. Methods of procedure in letting and conducting contract work, and the engineer's relation thereto. Required of all engineering students. Senior, second semester, three hours, at 11:25. Three credits. Marvin.

54.—HYDRAULIC CEMENT. A laboratory course in testing hydraulic cements and making comparison of their qualities. Reading, experimental work, and reports of tests made. Senior, second semester, two hours, Monday or Thursday, 3:30 to 5:30. One credit. J. O. Jones.

55.—MASONRY. Character of materials composing masonry. Methods of cutting and dressing stone. Foundations: Cribwork, cofferdams, caissons, piles and pile driving, concrete, pneumatic processes, etc. Senior, first semester, three hours, at 11:25. Three credits. ———.

56.—ROADS AND PAVEMENTS. A study of the materials for and methods used in the construction and improvement of country roads and city pavements. Earthwork, drainage, the road foundation, the wearing surface, etc. The economic importance of the "good-roads movement." Junior, second semester, two hours, at 11:25. Two credits. Dalton.

57.—RAILWAY LOCATION. The principles involved in economic location and construction of railways. Analysis of traffic and operating expenses. The influence of proposed changes in location upon the amount of total revenue from traffic, the bonded debt and the corresponding fixed charges for interest, the operating expense, and the dividend-paying capacity of the road. Junior, second semester, three hours, at 9. Three credits. Dalton.

58.—RAILWAY SURVEYING. A study of the methods of laying out and constructing railways. The setting out of simple and compound curves and calculation of excavations and embankments. Yards, turnouts, and switches. Easement curves of various types. Calculation of waterways, and methods of staking out foundations for culverts and bridges. This course must be preceded by a general course in surveying. Junior, first semester, four hours, at 9, with field practice one-half day per week. Five credits. Dalton.

59.—SEWERAGE AND WATER SUPPLY. An elementary course in the collection, removal and disposal of city sewage. Separate and combined systems. Principles of the design and construction of sewers and storm drains. Brief study of the treatment of sewage by the standard processes. The collection, purification and distribution of water supplies. Requisites of a supply as to quality and quantity. Design of distribution, collection, storage and treatment works. First semester, four hours, at 9. Four credits. G. R. Jones.

61.—ROOFS AND BRIDGES. Analytical and graphical calculation of stresses in framed structures under various forms of loading. This course must be preceded by course 51 in mechanics. Senior, first semester, ten hours, 1:30 to 3:30. Five credits. H. A. Rice.

62.—BRIDGE DESIGNING. A study in bridge details and the dimensions of parts. Students work out designs for a plate girder and a simple truss. Must be preceded by course 61. Senior, second semester, ten hours, 1:30 to 3:30. Five credits. H. A. Rice.

64.—SANITARY ENGINEERING DESIGN. An advanced course, to follow course 59. A more detailed study of the principles of good design of engineering works for sewerage and drainage, for the purification of public water supplies, and for the treatment of city sewage and of industrial wastes. Lectures, recitations and library reading; drawing-board designs of typical constructions; visits to sanitary engineering works. Senior, second semester, five hours, at 8. Five credits. G. R. Jones.

65.—REINFORCED CONCRETE. A course in the modern theory and practice of the design of beams, floor slabs, columns, retaining walls, conduits, arches, and other forms of reinforced concrete construction. Mathematical theory, study of plans, and design of typical structures. Senior, second semester, three hours, at 9. Three credits. H. A. Rice.

66.—MAINTENANCE OF WAY. An advanced course in railway engineering. Optional for Seniors, second semester, four hours, at 8. Four credits. Dalton.

67.—MUNICIPAL ENGINEERING DRAWING. A drawing-room course dealing with city maps and plats, street profiles and cross-sections, sewerage and drainage maps, standard plans for street pavements, street intersections, catch basins, storm-water drains, concrete bridges, and other work commonly found in a city engineer's office. Junior, first semester, six hours, Monday and Wednesday, 1:30 to 4:30. Two credits. G. R. Jones.

69.—SANITARY SCIENCE AND PUBLIC HEALTH PROBLEMS. A broad and general view of the large body of sanitary science upon which the modern practice of sanitation is based. The effects of good practice in such matters as public water supply, sewerage and drainage, state and federal control over the pollution of streams, street cleaning, refuse collection and disposal, and the ventilation of public buildings. Junior, second semester, three hours, at 9. Three credits. G. R. Jones.

70.—SANITARY ENGINEERING LABORATORY. A laboratory course in connection with experiment station work in water or sewage purification. Quick approximate methods of testing sewage effluents and of securing information relative to the controlling characteristics of water supplies. Junior, second semester, two hours, Tuesday, 3:30 to 5:30. One credit. G. R. Jones.

71.—SURVEYING. A briefer course than number 2, primarily for Senior mechanical and electrical engineering students. First semester, hree hours, at 11:15. Three credits. Stradling.

72.—SANITARY INSPECTION AND REPORTS. Visits to neighboring engineering works of sanitary interest, particularly waterworks and water and sewage purification plants, and to various municipal works in process of construction. By appointment. G. R. Jones.

For other courses in civil engineering, see The College.

ECONOMICS.

Professor MILLIS.
Assistsant Professor PUTNAM.

1.—ELEMENTS OF ECONOMICS. Three hours. Given each semester, at 10:25, 11:25, and 2:20. This course endeavors to explain the general laws of man's relation to wealth. While it furnishes the basis for the scientific understanding of business activities and serves as a foundation for all courses in economics, it is essentially a concrete, analytical study of the phenomena of economic life. Millis and Putnam.

ELECTRICAL ENGINEERING.

Professor SHAAD.
Assistant Professor C. A. JOHNSON.
Mr. SCHOOLEY, Instructor.

Courses 50 to 52, and 54 to 58, inclusive, and 61 are required of all electrical engineering students. Courses 50, 53, 54, and 55 are required of mechanical engineering students. Courses 59 and 62 are optional for electrical engineering students.

50.—DYNAMO MACHINERY. Theory of direct-current generators and motors. Prerequisites, physics 1E and 2E. Junior, first semester, three hours, at 11:25 for electrical engineering students and at 8 for senior mechanical engineering students. Three credits. C. A. Johnson.

51.—THEORY OF ALTERNATING CURRENTS. A mathematical treatment of alternating-current phenomena and the theory of alternating-current machinery, fundamental types. Prerequisite, course 50. Junior, second semester, five hours, at 11:25, for electrical engineering students. Five credits. Shaad.

52.—DYNAMO MACHINERY. Advanced theory of alternating-current machinery. Senior, first semester, five hours, daily, at 8. Five credits. Shaad.

53.—THEORY OF ALTERNATING CURRENTS. A study of the theory of alternating currents and alternating-current machinery, together with a discussion of motor applications. Prerequisite, course 50. Senior, second semester, three hours, at 8, for mechanical engineering students. Three credits. Shaad.

54.—ELECTRICAL LABORATORY. An experimental course for the purpose of illustrating the principles of direct-current dynamo machinery and acquainting the student with the types and performance of direct-current apparatus. Must be preceded or accompanied by course 50. Junior, first semester, three hours, two days per week on alternate weeks, 1:30 to 4:30. One and one-half credits. C. A. Johnson and Schooley.

55.—ELECTRICAL LABORATORY. A continuation of course 54. Must be preceded or accompanied by course 51. More advanced work with direct-current machinery is given and experiments with alternating-current apparatus are introduced. Some time is devoted to the calibration of electrical instruments. Junior, second semester, three hours, two days per week on alternate weeks, 1:30 to 4:30. One and one-half credits. C. A. Johnson and Schooley.

56.—ELECTRICAL LABORATORY. Advanced experiments with electrical machinery and the testing of machines, chiefly of alternating-current types. Must be accompanied by course 52. Senior, first semester, three hours, two days per week, 1:30 to 4:30. Two credits. Shaad and Schooley.

57.—ELECTRIC LIGHTING. A course in illumination and photometry in which the available light sources are studied, and the methods of application to artificial illumination of streets and buildings are discussed. Laboratory and field work in the measurement of light sources and illumination. Senior, second semester, three hours, at 11:25. Three credits. C. A. Johnson.

58.—ELECTRIC POWER TRANSMISSION AND ELECTRIC RAILWAYS. A series of lectures and recitations devoted to the study of the principles involved and the methods used in the design of transmission and distributing systems and the theory and practice of the design, construction and operation of electric railway systems. Prerequisite, course 52. Senior, second semester, five hours, at 9. Five credits. C. A. Johnson.

59.—ELEMENTARY TELEPHONY. Lectures, recitations, and laboratory work. The principles that underlie all telephone apparatus, and practical experiments with the fundamental telephone transmitters, receivers, and central-station arrangements. Optional, Juniors or Seniors, second semester, five hours, by appointment. Five credits. Shaad.

60.—ELEMENTS OF ELECTRICAL ENGINEERING. A course covering the general field of electrical engineering and prepared especially for civil engineering students. Junior or Senior year, second semester, five hours, at 9. Five credits. Shaad.

61.—PROFESSIONAL THESIS. Senior, first semester, three hours, and second semester, nine hours, by appointment. Shaad, or other instructors, according to the line of work chosen.

62.—ELECTRICAL ENGINEERING PRACTICE. The discussion of practical engineering problems as presented to the professional engineer and the determination of the most suitable electrical machinery to be selected for the work to be done. The course is complementary to mechanical engineering 59. Optional, Seniors, second semester, three hours, at 10:25. Three credits. Shaad.

63.—ADVANCED ELECTRICAL LABORATORY. A continuation of electrical laboratory 56. More advanced and extended experiments with electrical machinery and circuits, introducing the experimental study of transient electrical phenomena. Seniors, second semester, by appointment. Five credits. C. A. Johnson.

64.—ELECTRICAL ENGINEERING FOR ARCHITECTS. A course covering electrical installation for buildings. For students in architectural engineering, either Junior or Senior year. First semester, three hours, at ——. Three credits. Shaad.

ENGLISH LANGUAGE AND LITERATURE.

Assistant Professor RAYMOND.
Mr. MCCARTY, Instructor.
Miss LAIRD, Instructor.

The instruction in this department, while in essentials parallel to that in the College, is shaped with special reference to the other work of engineering students. The three courses here numbered are required before graduation; for students who wish to spend more time in work of this kind a research class is provided, and appropriate classes in the College are open.

1E.—RHETORIC. Written exercises and papers, with study of language usage. Required of all Freshmen. First semester, three hours, at 8, 9, 10:25, 11:25, 3:30, or 4:30. Three credits. Raymond, McCarty, and Laird.

2E.—RHETORIC. Continuation of course 1. Second semester, two hours, at 8, 9, 10:25, 11:25, 3:30, or 4:30. Two credits. Raymond, McCarty, and Laird.

50E.—ADVANCED COMPOSITION. Practice in the gathering and analyzing of material, and in the presentation of information and opinion in scientific papers, and study of the methods used in these and other papers. Required of all students, one semester in Junior or Senior year, three hours: first semester, at 8; second semester, at 9. Three credits. Raymond.

INDEXING AND RESEARCH IN THE LITERATURE OF ENGINEERING SCIENCE. Informal class, with headquarters in the office of this department, meeting once a week for conference, and working in the material of the engineering library.

The department of English is provided with references, illustrative matter, and other helps for reading in general and in engineering literature, and in the preparation of special papers.

GEOLOGY.

Professor HAWORTH.
Assistant Professor TODD.
Assistant Professor TWENHOFEL.

1.—ELEMENTARY GEOLOGY. A study of the elementary principles of geology, including a general outline of geologic principles and geologic agencies. An acquaintance with the elements of chemistry, zoölogy, and botany will be of advantage in this course. Required of Junior civil and Sophomore mining engineering students; first semester, five hours, at 9, 10:25, 11:25, or 2:30; second semester, at 9, 10:25, 11:25, or 2:30. Five credits. Todd and Twenhofel.

52.—ECONOMIC GEOLOGY I. A general study of the metallic and nonmetallic products of the mine and quarry, considered from a scientific and practical standpoint, including the nature, origin, amount and geographic and geologic distribution of the same. Must be preceded by elementary chemistry and course 1, or mineralogy 1E. Required of Junior mining engineering students, first semester, lectures and library work, three hours, Monday, Wednesday, and Friday, at 9. Three credits. Haworth.

53.—ECONOMIC GEOLOGY II. A continuation of course 52. Nonmetallic products. Second semester, two hours, Tuesday and Thursday, at 10:25. Two credits. Haworth.

Other courses in geology are open as optionals to engineering students. For details, see the courses listed under The College.

GERMAN.

Dr. SEIPT, Instructor.
Mr. STUBBS, Assistant Instructor.
Mr. KELLERMANN, Assistant Instructor.

1.—OUTLINE OF GRAMMAR. The first twenty-two lessons of Carruth's Otis's Grammar, with composition exercises; Carruth's Reader, about fifty pages. First semester, five hours, at 9. Five credits. Stubbs.

2.—READER AND GRAMMAR. The last eight lessons of Carruth's Otis's Grammar; Carruth's Reader completed. Schiller's Wilhelm Tell. First semester, five hours, at 1:30; second semester, five hours, at 9. Five credits. Seipt and Stubbs.

3.—GERMAN PROSE. Lessing's Minna von Barnhelm; extracts from Schiller's Der dreiszigährige Krieg, preceded by a review of grammar. First semester, five hours, at 8; second semester, five hours, at 10:25. Five credits. Seipt and Kellermann.

4.—SCHILLER'S WALLENSTEIN; SCIENTIFIC PROSE. Second semester, five hours, at 8. Five credits.

MATHEMATICS.

Associate Professor Ashton.
Assistant Professor White.
Assistant Professor Jordan.
Assistant Professro Duval.
Mr. Wheeler, Instructor.
————, Instructor.

2.—College Algebra. Review of elementary algebra; graphic representation; logarithms; determinants. Required of all Freshmen in the School of Engineering; first semester, three hours, at 8, 9, 10:25, 11:25, 2:30, or 3:30; second semester, three hours, at 3:30. Three credits. Jordan, Duval, Wheeler, and ———.

3.—Plane Trigonometry. The six trigonometric functions; principal formulas of plane trigonometry; solution of triangles and practical problems. Required of all Freshmen in the School of Engineering. First semester, two hours, at 8, 9, 10:25, 11:25, 2:30, or 3:30; second semester, two hours, at 1:30 or 3:30. Two credits. Jordan, Duval, Wheeler, and ———.

4E.—Theory of Equations and Analytic Geometry. Elementary theory of equations; Horner's method; the straight line and circle; conic sections; higher plane curves; solid analytic geometry. Required of all Freshmen in the School of Engineering. First semester, five hours, at 9; second semester, five hours, at 8, 9, 10:25, 11:25, or 2:30. Five credits. Ashton, White, Jordan, Duval, Wheeler, and ———.

5E.—Calculus I. Differential calculus; applications to geometry and mechanics; maxima and minima; integral calculus; simple applications to lengths, areas, and volumes. Required of all Sophomores in the School of Engineering. First semester, five hours, at 9, 10:25, and 11:25; second semester, five hours, at 9. Five credits. Ashton, White, Jordan, and Duval.

6E.—Calculus II. Applications of the calculus to problems in solid geometry; double and triple integration; applications to areas, volumes, centers of gravity, and moments of inertia; simple differential equations. Required of all Sophomores in the civil, electrical, and mechanical courses. First semester, three hours, at 10:25; second semester, three hours, at 10:25 and 11:25. Three credits. Ashton and White.

7E.—Selected Topics in Engineering Mathematics. Complex numbers and vectors; exponential and trigonometric series; differential equations of electrical and mechanical engineering; empirical curves; methods of approximation and numerical calculation. The course may be modified to suit the needs of the class. Optional for Juniors and Seniors. Second semester, three hours, by appointment. Jordan.

For other courses in mathematics, see The College.

MECHANICAL DRAWING.

Associate Professor HOOD.
Assistant Professor COCHRAN.
Mr. J. O. JONES, Instructor.

1.—FREE-HAND DRAWING. Engineering lettering in pencil and in ink. Free-hand working sketches of simple machine parts. Freshman, first nine weeks of both semesters; Monday, Wednesday, and Friday, at 8 to 10, 10:25 to 12:15; Monday and Thursday, 1:30 to 4:30; Tuesday and Friday, 1:30 to 4:30; or Wednesday, 1:30 to 4:30, and Saturday, 8 to 11, six hours. One credit. Hood, Cochran, and J. O. Jones.

2.—ELEMENTARY MECHANICAL DRAWING. Working drawings of simple machine parts. Penciling, tracing, and blue-printing. Detailing machine parts from assembly drawings. Freshman, last nine weeks of both semesters, same hours as in course 1, six hours. One credit. Hood, Cochran, and J. O. Jones.

3.—DESCRIPTIVE GEOMETRY. Principles of projection. Execution of a large number of original exercises. Freshman, second semester, three hours, at 8, 9, 10:25, 11:25, 2:30, or 3:30, also first semester, at 9. Three credits. Hood, Cochran.

4.—MACHINE DRAWING. Sketching of machine parts and preparation of working drawings; detailing of machines from sketches, notes, assembly drawings and assembled machines; tracing and blue-printing; notes and lectures on drafting-room methods. Each student prepares complete drawings for some simple machine. Freshman, both semesters, same hours as in course 1, six hours. Two credits. Hood, Cochran.

MECHANICAL ENGINEERING.

Professor WALKER.
Associate Professor SIBLEY.
Assistant Professor COCHRAN.
Assistant Professor SLUSS.
Assistant Professor CARVER.

1.—MACHINE DRAFTING. Making of working drawings from sketches of assembled parts followed by an assembly drawing from detailed working drawings. Sophomore, first semester, Monday or Wednesday, 1:30 to 4:30, three hours. One credit. Garver.

2.—MECHANISM. A study of the motion of machine parts and of methods of transmission of motion by gears, belts, cams, and links. Recitations and drawing for mechanical students. Text, "Mechanism." Sophomore, first semester, Tuesday and Thursday at 11:25, and Thursday 1:30 to 4:30. Three credits. Garver.

3.—ELEMENTARY MACHINE DESIGN. Design of representative machine parts. Assembly of such parts and study of their relative motions. Sophomore, second semester, for electrical engineering students. Tuesday and Thursday at 9, and 1:30 to 4:30 on Thursday. Three credits. Garver.

4.—STEAM BOILERS. (*a*) Fuels, combustion, and steam generation. (*b*) A study of boiler and engine types. Principal text, Kent's "Steam Boiler Economy." Sophomore, second semester, two hours, Monday and Wednesday, at 10:25 or 11:25. Two credits. Cochran.

5.—ENGINES AND BOILERS. A brief study of the general problem of steam-power generation from the standpoint of the installing engineer. Text, "Heat Engines," by Allen and Bursley. Required of civil engineering students. Sophomore, second semester, Monday, Wednesday and Friday, at 9, and five exercises in the steam laboratory on Saturday, 8 to 12. Three credits. Garver.

6.—STEAM ENGINEERING. Elements of steam machinery, with special reference to combustion of fuels, boiler types, and engine mechanism, including the study of valve gears by the Bilgram diagram. Laboratory practice in proximate analysis of coal, and flue-gas analysis. Sophomore, second semester, for mechanical engineering students. Monday, Wednesday and Friday, at 11:15, and Thursday, 1:30 to 4:30. Four credits. Sluss and Garver.

50.—MACHINE DESIGN. Analytical and graphical solution of problems in the design of machine parts, transmission and hoisting devices. Junior, second semester. Monday and Wednesday, at 10:25, and Friday, 1:30 to 4:30. Four credits. Garver.

51.—THERMODYNAMICS. The relations between heat and mechanical energy; theory of heat engines. Must be preceded by physics 1 E and calculus. Text, Ennis's "Thermodynamics." Required of mechanical engineering students. Junior, first semester, at 10:25. Four credits. Sibley.

52.—HEAT ENGINE THEORY. A course for electrical engineering students, treating the science of thermodynamics more briefly than in the preceding course and including engine application. Junior, first semester, at 11:25. Three credits. Walker.

53.—MECHANICS OF THE STEAM ENGINE. Course outlined in course 50 is followed through for a particular engine, together with the design of the engine parts. Required of electrical students, Junior, second semester, three hours, Tuesday and Thursday, at 10:25. Two credits. Sluss.

54.—HEATING AND VENTILATION. Laws of heat tansfer; amount of air required for ventilation; methods and apparatus employed in modern buildings; central heating plants. Junior, second semester, two hours, at 9. Two credits. Sibley.

55.—REFRIGERATION. Principles of mechanical refrigeration. Ice manufacturing and cold storage plants from the standpoint of American practice. Recitations, designing room work, and laboratory exercises with ammonia machine. Optional, first semester, Monday, Wednesday and Friday, at 9. Three credits. Sluss.

56.—STEAM ENGINE DESIGN. Valve motions, governors, inertia forces and flywheels, balancing, simple and compound engines, engine details. Senior, first semester, Tuesday and Thursday, 8 to 10. Outside preparations required. Two credits. Sibley.

57.—STEAM-TURBINE DESIGN. Calculation and design of nozzles and blading of impulse and reaction types of turbines. Structural design. Senior, second semester, two hours class, (*a*), Monday and Wednesday, at 11:25, and four hours designing, Monday, 1:30 to 5:30. Three credits. Sibley.

58.—GAS-ENGINE DESIGN I. General theory and practice of gas-engine design and construction. Text, Lucke's "Gas-engine Design." Senior, first semester, one hour class, Monday and Tuesday, at 1:30, Wednesday and Thursday of alternate weeks, 1:30 to 4:30. Three credits. Sibley.

59.—GAS-ENGINE DESIGN II. Application of principles covered in course I to design of special types of gas engines. Senior optional, second semester, by appointment. Three credits. Sibley.

60.—HYDRAULIC DESIGN. Waterpower development. Rainfall and run-off; stream flow; preliminary plant layout; selection of standard water turbines; turbine design. Senior optional, first semester, Wednesday, at 11:25, and Friday, 10:30 to 12:15. Three credits. Not offered 1913-'14. Walker.

61.—STRUCTURAL DESIGN. Stresses in the frames of steel buildings, and design of the members of the structure. Optional for Seniors specializing in mill engineering. First semester, Monday, Wednesday and Friday, at 9. Three credits. Sibley.

62.—INDUSTRIAL PLANT DESIGN. Planning of manufacturing plants; location, transportation; routing of work; handling material. Senior optional, second semester, Wednesday and Friday, at 9, designing room three hours by appointment. Three credits Sibley.

64.—MECHANICAL LABORATORY. Theory and use of planimeters; calibration of apparatus; cement testing; valve setting; coal calorimetry; physical properties of lubricating oils. First semester, three hours, Tuesday or Thursday, 1:30 to 4:30. One credit. Garver.

65.—HEAT ENGINE LABORATORY. Experimental engineering methods; engineering literature bearing upon power development; laboratory tests of steam and gas prime movers, compressors, refrigerating units, etc. Drill in report writing. Must be preceded by thermodynamics. Senior, first semester, for electrical students, Tuesday or Thursday, 1:30 to 5:30. Second semester, for mechanical students, Wednesday, 1:30 to 5:30. One lecture per week and report writing outside of laboratory time. Two credits. Sluss, Garver.

67.—THESIS. Senior, both semesters, Friday, 1:30 to 4:30. Three credits. Sibley and Sluss.

68.—SUMMER VACATION WORK. Two months to be spent in regular work in some shop or manufacturing plant of good standing. A report on this work, with a certified statement from the shop foreman or the superintendent, must be presented before credit can be given.

69.—SHOP ADMINISTRATION. Study of methods of routing and following up work in the shop; time study of machine processes;

practice in instruction-card writing. Lecture on Friday at 8, and practice work by appointment. Junior, second semester. Two credits. Garver.

70.—WORKS MANAGEMENT. Modern industrial plant organization; principles of cost accounting; labor wage systems; distribution of indirect expense; power economics. Lectures, problems, and assigned reading. Senior, second semester. Two credits. Walker.

For courses open to graduate students, see Graduate School.

MECHANICS AND HYDRAULICS.

Associate Professor H. A. RICE.
Associate Professor HOOD.
Assistant Professor ———.
Mr. J. O. JONES, Instructor.

50.—MECHANICS. A study of the laws of statics and dynamics. Action of forces upon bodies and the resulting motions. Required of all engineering students. Junior, both semesters, five hours, at 8 or 9. Five credits. H. A. Rice, Hood, and ———.

51.—STRENGTH OF MATERIALS. The theory of resistance to stress and application to engineering construction. Required of all engineering students. Junior, both semesters, four hours, at 8 or 10:25. Four credits. H. A. Rice, Hood, and ———.

52.—TESTING OF MATERIALS. A laboratory course to accompany course 51. The testing of iron, steel, wood and other materials of construction for resistance to tension, compression, torsion, bending, and shearing. Experimental determination of the limits of safe loading. The testing of paving brick. Junior, second semester, four hours, Monday, Wednesday, Thursday, or Friday afternoon, or Saturday morning. One credit. ———, and J. O. Jones.

53.—GRAPHICAL STATICS. The properties of equilibrium polygons and other methods of representing the actions of forces, with application to the determination of stresses in beams, roof-trusses, and stone arches. Lectures and drawing. Junior, second semester, nine hours, 1:30 to 4:30. Three credits. ———.

54.—ENGINEERING MATERIALS. A study of the methods of manufacture of structural materials and the different means and machines used in their testing. Opportunity will be given for specialization along some particular line, if desired, and considerable experimental work may be done in the laboratory. Recitations, lectures, library, and laboratory work. Optional for Seniors, second semester, five hours, by appointment. Five credits. H. A. Rice.

55.—HYDRAULICS. A study of the laws governing the pressure and flow of liquids. Calculation of the flow through pipes and over weirs. The principles and types of pumping and hydraulic power machinery. Senior, first semester, three hours, at 10:25. Three credits. ———.

56.—HYDRAULIC LABORATORY. A course to accompany course 55. Experimental work with the flow of water over weirs, through orifices and pipes, and in testing hydraulic machinery. Required of civil and mechanical engineering students. Senior, first semester, two hours, Monday, Wednesday, or Friday, 3:30 to 5:30. One credit. ———, J. O. Jones.

METALLURGY.

Associate Professor WHITAKER.

57.—ASSAYING AND METALLURGICAL ANALYSIS. The first half of the semester is devoted to the fire assay of gold, silver, and other metals; the second half to the volumetric assay of ores and furnace products. Junior mining engineering students are required to take the entire course, and receive five credits; the Senior chemical engineering students are required to take fire assaying the first half of the semester, and will receive two and one-half credits. Second semester, five or ten hours, two afternoons per week. Two and one-half or five credits. Whitaker.

61E.—METALLURGY I. General metallurgy and metallurgy of iron and steel. Lecture and recitations. Must be preceded by chemistry 3. Required of Junior mechanical engineering students and Senior chemical engineering students. First semester, three hours, at 9. Three credits. Whitaker.

62E.—METALLURGY II. Metallurgy of lead, zinc, and copper, followed by that of silver, gold, mercury, and tin. Prerequisite, chemistry 3. Required of Senior mining and chemical engineering students. Second semester, three hours, at 9. Three credits. Whitaker.

63.—METALLURGICAL LABORATORY. Pyrometric and calorimetric measurements, preparation of silicates and alloys, oxidation and reduction reactions, amalgamation, chlorination, cyaniding and leaching, etc. Optional for Juniors, Seniors, and graduate students who have taken or are taking metallurgy 61 or 62. Either semester, two hours, by appointment. Whitaker.

64E.—GENERAL METALLURGY. A repetition in briefer form of course 61E. Required of Senior mining engineering students, second semester, two hours, at 9. Two credits. Whitaker.

MINERALOGY.

Professor HAWORTH.
Assistant Professor TODD.

1E.—ELEMENTARY MINERALOGY I. A brief course in crystallography, blowpipe analysis, and systematic mineralogy, consisting of lectures and laboratory work. Sophomore, second semester, five hours, 3:30 to 5:30. Five credits. Todd.

62E.—PETROGRAPHY. This course includes a study of the mineralogical and chemical composition of rocks, their origin, structural features and classification. Second semester. Five credits, Haworth.

Other courses in mineralogy are open to engineering students as optionals. For these, see The College.

MINING ENGINEERING.

Professor HAWORTH.
Associate Professor C. M. YOUNG.
Associate Professor HUMBLE.

50.—MINING. Underground surveying, to be supplemented by field work. Excavation for mining purposes, quarrying, boring for gas, oil, and water. Manufacture and use of explosives. Sinking of shafts, tunneling, support of underground excavations. Lectures and recitations. Junior, first semester, five hours, at 11:25. Five credits. C. M. Young.

51.—ORE DRESSING. Methods used for the separation and concentration of valuable minerals. Recitations, lectures, and laboratory work. Richard's "Text Book of Ore Dressing." Senior, first semester, three hours, at 9, (three credits); second semester, three hours, at 10:25, (three credits). C. M. Young.

52.—POWER, EXTRACTION, DRAINAGE, VENTILATION. Steam, compressed air, and electricity as applied to mining; mining hydraulics and the drainage of mines; handling of ore underground and on the surface; ventilation; mine accidents. Includes a visit to the lead-zinc district of Kansas and Missouri and a report. Senior, first semester, five hours, at 10:25. Five credits. C. M. Young.

53.—SAMPLING AND EXPLOITATION. Methods of sampling, developing, and working mineral deposits, including studies of important mining districts. Senior, second semester, (*a*), five hours, at 11:25. Two and one-half credits. C. M. Young.

54.—MINE PLANT. Equipment necessary for the exploitation of mineral deposits and of important examples; building materials, foundations, mine buildings; the design of mine plants. Optional for students of mining engineering. Senior, second semester, five hours, at 9. Five credits. C. M. Young.

55.—MINE ADMINISTRATION. Mine accounts and management; care of sick and injured in case of accident; rules and regulations for equipping expeditions and maintaining camps. Optional for mining engineering students. Senior, first semester, (*a*), five hours, by appointment. Two and one-half credits. C. M. Young.

56.—COAL MINING. Methods of working coal beds and of handling coal. Properties of mine gases, safety lamp; explosives; ventilation; cause and prevention of explosions. May be substituted for mining 52. Open to students not enrolled in the course in mining engineering. Second semester, five hours, at 9. Five credits. C. M. Young.

57.—MINING LAW. Outline of the laws relating to the mining industries. Recitations and lectures. Second semester, one hour, in alternate years. (Not given in 1913-'14.) Humble.

58.—PROFESSIONAL THESIS. This may be an elaborate description of a mining or metallurgical plant or of a mining district, or may be founded upon research work done at the University.

59.—SUMMER WORK. Each candidate for a degree is required to give evidence of having had experience in some phase of mining work. This may be gained by an investigation of some mining district under the direction of an instructor for a period of six weeks, or by employment in mining work.

60.—MINING DRAWING. Drawing and coloring mine maps and mine sections. Use of symbols to show nature of geological structure. Coal-mine maps. Sophomore, second semester, three hours. One credit. C. M. Young.

PHYSICAL EDUCATION.

Professor NAISMITH.
Mr. ROOT, Instructor.

The aim of the work is mainly hygienic and recreative. In accomplishing this the future work of the engineer will be kept in mind, and the kind of work used will tend to develop the qualities needed in the life of an engineer, such as balancing, climbing ropes and ladders, transporting objects over difficult places, swimming, and some of the combative sports.

Special classes will be organized for engineers at such times as the majority can attend. Attendance will be required three hours per week.

Those specially qualified may substitute such games as are conducted by coaches, during the season in which they are played.

PHYSICS.

Professor KESTER.
Associate Professor M. E. RICE.
Assistant Professor STIMPSON.
Mr. T. T. SMITH, Instructor.
Mr. R. K. YOUNG, Instructor.

1E.—GENERAL PHYSICS. A fundamental course of experimental lectures, recitations, and problems. Prerequisites, plane trigonometry and some knowledge of analytical geometry and calculus. Sophomore, first semester; lectures and recitations on Monday, Tuesday, Wednesday, and Thursday, at 11:25; laboratory two hours, Tuesday or Thursday, at 8 to 10, or Monday, 1:30 to 3:30. Given also in the second semester; lectures and recitations on Monday, Tuesday, Wednesday, and Thursday, at 10:25; laboratory two hours, Wednesday or Friday, 1:30 to 3:30. Five credits. M. E. Rice, Kester, Stimpson, T. T. Smith, and R. K. Young.

2E.—GENERAL PHYSICS. A continuation of course 3. Sophomore, second semester, lectures and recitations on Monday, Tuesday, Wednesday, and Thursday, at 11:25; laboratory two hours, Monday, Wednesday, or Friday, 8 to 10, or Monday, 1:30 to

3:30. Given also in the first semester; lectures and recitations on Monday, Tuesday, Wednesday, and Thursday, at 10:25; laboratory two hours, Wednesday or Friday, 1:30 to 3:30. Five credits. M. E. Rice, Kester, Stimpson, T. T. Smith, and R. K. Young.

52.—THEORY OF ELECTRICITY AND MAGNETISM. Junior, first semester, three hours, at 9. Three credits. M. E. Rice.

60E.—ELECTRICAL MEASUREMENTS I. A laboratory course coordinate with 52. First semester, three hours per week, by appointment. One and a half credits. M. E. Rice.

61E.—ELECTRICAL MEASUREMENTS II. Continuation of course 60E. Second semester, three hours, by appointment. One and one-half credits. M. E. Rice.

For other courses in physics, see The College and The Graduate School.

ROMANCE LANGUAGES.

Professor GALLOO.
Assistant Professor WINTER.
Miss MAY GARDNER, Instructor.

French.

1.—ELEMENTARY FRENCH I. Grammar (Fraser and Squair) and easy reading. Drill in pronunciation, accidence, and easy syntax. Open to students who have had three years of Latin or German. First semester, five hours, at 10:15. Five credits. Miss Gardner.

Students who have had less than two years of a foreign language form a distinct section, meeting at 8.

2.—ELEMENTARY FRENCH II. A continuation of course 1. Reading of simple prose texts, with exercises in dictation and elementary composition. Second semester, five hours, at 10:25. Five credits. Miss Gardner.

For advanced courses in French, see The College.

Spanish.

1.—ELEMENTARY SPANISH I. An outline of grammar (Hills and Ford). Reading of short stories. Elementary composition. Open to students who have had three years of Latin, French, or German. First semester, five hours, at 9, 11:25, or 1:30. Also second semester, five hours, at 2:30. Five credits. Winter and Miss Gardner.

Students who have had less than two years of a foreign language form a distinct section, reciting during the first semester at 1:30.

2.—ELEMENTARY SPANISH II. Grammar and composition. Reading of easy modern prose. Carríón-Aza, Pérez Galdós, Palacio Valdés, etc. Second semester, five hours, at 9, 11:25, or 1:30. Five credits. Winter and Miss Gardner.

For advanced courses in Spanish, see The College.

SHOP WORK.

Assistant Professor F. E. WARD.
Assistant Professor F. E. JONES.
Mr. WILTFONG, Instructor.
Mr. LANDRUM, Instructor.
Mr. ROCKLUND, Instructor.

SHOP I.—ELEMENTARY FORGING AND LIGHT BENCH WORK. Building a fire; composition and properties of iron and mild steel; pointing, bending and light welding. Forging and tempering carbon-steel hand tools. Riveting and cutting threads. Three hours per week, one credit. Wiltfong.

SHOP II.—ELEMENTAL WOODWORKING AND MOLDING. A short comprehensive course in beginning shop work, comprising studies in the selection, care and use of the hand tools for woodwork. The fundamentals of joinery and wood turning are worked out in a series of definitely planned exercises. Optionals in elementary furniture making are given to those who demonstrate a satisfactory amount of skill. A fraction of the time allowed for this course is given to molding and elemental foundry practice. Three hours per week, each semester, one credit. F. E. Jones and Landrum.

SHOP III.—PATTERN MAKING AND FOUNDING. The theory and practice of wood pattern making are studied and discussed in short lecture-recitations. The principles of pattern construction, such as draft, shrinkage, fillet, core prints, core boxes, etc., are applied in a practical way by the students making patterns for actual use in the foundry. The foundry work consists of lectures and discussions on materials, methods of molding and core making, care and management of the cupola furnace, metallurgy of foundry irons, the brass furnace, melting and casting nonferrous alloys, etc., and practice work in the same lines. Each squad of students is required to have entire charge of the melting and casting of a heat of iron at least once during the course. Three hours per week, first semester, one credit. F. E. Jones and Rocklund.

SHOP IV.—ADVANCED FORGING, FILING AND BENCH WORK. Heavy welding, forging lathe tools and pliers; tempering and case-hardening. Exercises in bench work in drilling and polishing. Three hours per week, one credit. Ward and Wiltfong.

SHOP V.—LATHE WORK. The use and testing of tools made in shop IV. Centering work, turning on centers to fit standard gauges, turning tapers and curved surfaces, turning shafting, cutting threads, making cap screws. Three hours per week, one credit. Ward.

SHOP VI.—ADVANCED LATHE AND MACHINE-TOOL WORK. Making close fits with ordinary calipers; cutting special screws and inside threading; machining and boring castings with high-speed tools, from blue prints and drawings. Three hours per week, one credit. Ward.

SHOP VII.—TOOL MAKING AND ASSEMBLING. Making gears, taps, reamers and mandrels; tempering and grinding hardened work; erecting and laying out work from drawings. Three hours per week, one credit. Ward.

SUMMER SHOP PRACTICE. Four weeks of 44 hours per week. The work is the same as that covered by shop IV, shop V, shop VI and shop VII, beginning for each student at the point where his preceding work terminated. Required of mechanical and electrical students at the end of the Sophomore year.

TECHNICAL REPORTS AND THESES.

Special written reports are required from each student at certain times during his course of study, generally one in each semester of the Sophomore year, one in the Junior year, and one in the Senior year. A student enrolled for Technical Report I, II, III or IV confers with his instructor for assignment of the subject on or before October 15 for the first semester, and on or before March 15 for the second semester. The finished reports must be in the instructors' hands by January 15 and May 15 of the respective semesters. Each report counts for one-half credit.

A special thesis is required of each student before his graduation. See "Thesis" in the description of courses of the professional departments.

Standard forms for the make-up of technical reports, theses, and other written papers are specified in an official circular to be had at the Dean's office.

ENGINEERING LECTURES.

A course of special lectures is given to the Freshmen during the first semester by members of the Engineering Faculty. The purpose of the lectures is twofold: first, to give the student a more adequate idea of engineering as a profession and in its relation to the economic and industrial world; second, to enable those students who have not decided upon the courses of study to be pursued to gain a more definite conception of the field covered in each, and the requirements for success.

In connection with each professional course of study there is regularly maintained a journal meeting for the review of current engineering literature, or a society for the discussion of engineering topics. These societies are described more fully among the "University Organizations," page 46. Through the efforts of these societies and of the members of the Engineering Faculty a large number of lectures by practicing engineers are secured during the year.

SUMMER WORK.

In several of the courses of study practical work in one or two summers is required. This work is not measured in terms of credit hours, although in fixing the requirements for graduation one or two additional credit hours are required in those courses of study which do not include summer work.

INSPECTION TRIPS.

As a valuable adjunct to resident study at the University, inspection trips to various engineering works are required to be taken by students with their instructors. Such trips may be made to large machine shops, power plants, steam or electric railways, lighting systems, city waterworks, sewerage systems, industrial chemical plants, cement works, mining plants, or smelters. These trips may be made during regular sessions of the school or during vacation. Parties sometimes travel as far as Chicago or St. Louis. The trips requiring absence from other work and those of considerable expense are indicated in the schedules of required work.

School of Engineering.

SENIORS.

Armstrong, Clinton Garrett,	*Kansas City, Mo.*
Arnold, Leroy,	Piedmont.
Belt, Edison,	Fredonia.
Bodman, Russell John,	Kansas City.
Bragg, Gilbert A.,	*St. Joseph, Mo.*
Broderick, George Harold,	Neodesha.
Bunn, Paul King,	La Crosse.
Burnham, Harry Edwin,	Wa Keeney.
Campion, Henry Hinkson,	Leavenworth.
Carpenter, Ross Lawrence,	Hiawatha.
Carson, Earl,	Peabody.
Chase, Harry Valentine,	Lawrence.
Coats, Charles Melvin,	Chanute.
Cone, Charles Luther,	Lawrence.
Crawford, Don Kahr,	Topeka.
Daniels, James Ganson,	Leavenworth.
Dodd, Clark Insley,	Fredonia.
Dunn, George Chester,	Hanover.
Finney, Roy A.,	Wamego.
Fox, William Fern,	Lawrence.
Frush, Ralph Sydney,	Kansas City.
Fuchs, Alfred Robert,	Kansas City.
Fuller, O. O.,	Geneseo.
Glenn, Guy Cecil,	Paola.
Godfrey, Truman Milo,	*Kansas City, Mo.*
Grignard, Emile E.,	Lawrence.
Hainbach, Charles John,	Chanute.
Halleck, Philo,	Abilene.
Hartman, Elmer Edward,	Kansas City.
Helm, Charles Frank,	*La Junta, Colo.*
Hennessy, Thomas Patrick,	Fulton.
Hoadley, Herbert Eugene,	Fort Scott.
Hobbs, Maurice Hill,	Fairview.
Hoffman, Ralph Nicolas,	Parsons.
Howard, J. Denton,	Eureka.
Jaques, Ewart Paul,	Kansas City.
Johnson, Amos Daniel,	*Kansas City, Mo.*
Jones, Thomas Roy,	Arkansas City.
Keraus, Arthur S.,	Wa Keeney.
Knerr, Lewis Ellsworth,	*Kansas City, Mo.*
Leatherock, Lloyd Edmond,	Cherryvale.
Lyder, Ernest Elmer,	Paola.
Madlem, Leo Smith,	Lawrence.
Malcolmson, James Donovan,	*Kansas City, Mo.*
Martin, Ransom Melvin,	Herington.
Messenger, Frank DeWitt,	Lawrence.
Meyer, Paul Alexander,	Centralia.
Mickey, D. DeWitt,	Junction City.
Moffett, Joseph Orr, Jr.,	Peabody.
Moore, Walter Nathaniel,	*Kansas City, Mo.*
Morton, Ira William,	Girard.
Murphey, George Robert,	*Oklahoma City, Okla.*
Nagle, Henry George,	*Kansas City, Mo.*
Peterson, George Oscar,	Lawrence.
Plank, William Jay,	Lawrence.
Price, William Francis, Jr.,	Topeka.
Richardson, Howard Logan,	Lawrence.
Riordan, Joseph Alphonsus,	Solomon.
Roberts, Clay,	Kansas City.

SENIORS—*concluded.*

Rush, Earl Samuel,	Axtell.
Ruth, B. Alvin,	Moundridge.
Schooley, Sparks Sylvester,	Lawrence.
Schwab, James West,	*Enid, Okla.*
Schwartz, Theodore,	*Kansas City, Mo.*
Seibel, Clifford Winslow,	*Kansas City, Mo.*
Shockley, Clyde Arthur,	*Kansas City, Mo.*
Staley, Harry,	Richmond.
Tangeman, William Henry,	Newton.
Thompson, Wayne Douglas,	Wichita.
Turkington, John Edward,	Cherokee.
Underwood, Andrew Benonia,	*Kansas City, Mo.*
VanHouten, Edwin A.,	Topeka.
Veatch, Francis Montgomery,	Atchison.
Ward, Richard B.,	Belleville.
Wright, Earl Leon,	Pleasanton.
Young, James Arthur,	Lawrence.

SENIORS, 76

JUNIORS.

Ackerman, Henry Calvin,	Rosedale.
Adams, Clyde Melvin,	Topeka.
Allen, Glenn Lee,	Lawrence.
Allison, Lawrence M.,	Lawrence.
Angevine, Leland Charles,	Lawrence.
Armstrong, Frank Logan,	Lawrence.
Baldwin, Ernest Joy,	Cherryvale.
Baugher, Howard Nathan,	Kinsley.
Bliss, John Lawrence,	Winfield.
Bolinger, Lyman E.,	Clearwater.
Bracewell, Russell Starkey,	Kincaid.
Brouk, James Anton,	Wilson.
Brown, Loren Elden,	Delphos.
Brown, Will E.,	Robinson.
Butler, John Shadel,	*Kansas City, Mo.*
Cadwell, Harold Vernon,	*Nowata, Okla.*
Cassingham, Chester Snyder,	*Warrensburg, Mo.*
Charpie, Samuel James,	Kingman.
Cissna, Volney Judson,	Fort Scott.
Clarke, Clarence Stephen,	*Springfield, Mo.*
Coggins, Claude Lou,	Wamego.
Cunnick, Paul Carlton,	Lawrence.
Devlin, Floyd Barnard,	Newton.
Dingman, Oscar Aldrich,	Emporia.
Dodd, Leslie Harold,	Langdon.
Fairchild, Samuel Gilbert,	Hutchinson.
Fecht, Arthur John,	Kansas City.
Feierabend, Harold Herman,	Atchison.
Fillmore, Benjamin DeWitt,	Blue Rapids.
Fowler, Charles Vern,	Lawrence.
Greenlees, Charles Robert,	Lawrence.
Haag, Samuel McCarty,	Admire.
Hansen, Herbert C.,	Wellington.
Harsha, Luman McLaine,	Partridge.
Harshbarger, Eugene Lee,	Topeka.
Hazen, Daniel Francis,	Lawrence.
Hellener, Earl Edgerton,	Atchison.
Hess, Raymond,	Perry.
Holmes, Merle Verne,	Kansas City.
Hostetler, Curtis B.,	Belleville.
Hughes, Alfred Samuel,	Lawrence.
Hunter, Earl William,	Lawrence.
Jackson, Lyman Lewis,	Clay Center.
Kayser, Grier Milton,	Wilson.
King, Harlen Dwight,	Cawker City.

SENIORS—*concluded.*

Kinnear, Lawrence Wilson,	*New York City.*
Kleihege, Daniel Bertram,	Bison.
Kleihege, Henry Joseph,	Bison.
LaRue, James Eugene,	Lawrence.
Lauterbach, William John,	Colby.
Leake, John Bertram,	*Kansas City, Mo.*
Lynch, Francis John,	Herington.
Malcolmson, William Jack,	*Kansas City, Mo.*
Maltby, Arthur Raymond,	McPherson.
Mellick, Lloyd V.,	La Crosse.
Moore, Leo George,	Lawrence.
Moore, Raymond Francis,	Atchison.
Mylroie, John Miller,	Lawrence.
McCurry, John Allen,	Parsons.
Newby, Howard Lee,	*Acme, Tex.*
Nofsinger, Lewis Esmonde,	*Kansas City, Mo.*
Oman, Carl,	Garnett.
Painter, Carl Elliott,	Wichita.
Parker, James,	Independence.
Parkhurst, Ivan Paul,	Kinsley.
Pauly, Howard Clyde,	Lawrence.
Poundstone, Leon Harmon,	*Blackwell, Okla.*
Rankin, Donald Mark,	Paola.
Reid, Donald,	*Kansas City, Mo.*
Reymond, Paul LeGrand,	*Kansas City, Mo.*
Richards, Addison,	*Kansas City, Mo.*
Richardson, Encell Campbell,	Lawrence.
Rohrer, Walter Elmer,	*McAlister, Okla.*
Segel, Joseph,	McPherson.
Seger, Ralph Logan,	Topeka.
Severns, William H.,	Garnett.
Siegfried, Harry,	Burlington.
Smith, John Rhodes,	Sterling.
Sproull, John Steele,	Lawrence.
Steele, Russel Benton,	Garnett.
Tholen, Charles Webster,	Leavenworth.
Thomas, Raymond Sankey,	Lawrence.
Tillotson, Luther Rudolph,	Topeka.
Veirs, Cyrus Robb,	Independence.
Washburn, George Avery,	Topeka.
Weaver, Glenn Shellborn,	Concordia.
Weidlein, William Dale,	Olathe.
Welsh, Harry Esmond,	Chanute.
Wiedeman, Franz Gustav,	Lawrence.
Wise, Lyle Deards,	Lawrence.

JUNIORS, 90

SOPHOMORES.

Ames, Edwin Lee,	Caldwell.
Barth, Leon John,	*Broken Arrow, Okla.*
Bayles, Charles Gilbert,	Garrison.
Benedict, Frank Griffith,	Lawrence.
Benn, Lawrence Augustine,	La Crosse.
Berwick, Jo Douglas,	Lawrence.
Blachly, Fred Eben,	Herington.
Bocker, Leon Morris,	Solomon.
Bockemohle, Clinton Linus August,	Ellinwood.
Bradbridge, Ernest Eugene,	Hutchinson.
Brown, Hugh Reid,	Altoona.
Brown, Nathan Wallace,	Lawrence.
Burgess, Warren C.,	*Beatrice, Neb.*
Burnham, Elmer Jay,	Kansas City.
Carpenter, Loring Townsend,	Seneca.
Chapple, James Melvin,	Troy.
Constant, Clyde Stanley,	Lawrence.

SOPHOMORES—*continued.*

Curfman, Harry Monroe,	Winfield.
Day, Lloyd Joseph,	Glen Elder.
Degen, Fred Samuel,	*Kansas City, Mo.*
Dimmitt, Clarence Elmer,	Lawrence.
Ellis, Paul Ovid,	Parsons.
English, Marion Leslie,	Dodge City.
Francis, Chester M.,	Cherryvale.
Galloway, Ralph Arthur,	Hutchinson.
Geiger, Charles F.,	Ottawa.
Glaze, Carl Wilber,	Lyons.
Gray, Alfred,	Paxico.
Groft, Andrew Joshua,	Wa Keeney.
Harding, Clarence William,	Leavenworth.
Harding, Gilman Case,	Leavenworth.
Harris, Alfred,	Emporia.
Hartman, Fritz Vincent,	Junction City.
Harvey, Everett Clyde,	*Ulrich, Mo.*
Haskin, Fletcher,	Frankfort.
Holmes, Charles Bolivar,	Lawrence.
Hunter, Hayden Records,	Bucklin.
Hurd, Harold Baldwin,	*Kansas City, Mo.*
Jackson, Lloyd Earl,	Chanute.
Jespersen, Conrad Morris,	Lawrence.
Jones, Forrest Emery,	Neodesha.
Keeling, Ross Custer,	Oakley.
Kruse, Schiller,	Lawrence.
Lackey, Donald Haldane,	Peabody.
Laizure, Lawellin Boyd,	Lawrence.
Lentz, Roscoe Vernon,	*Kansas City, Mo.*
Lindley, Clifford Benjamin,	Medicine Lodge.
Logan, Carl Gillies,	*Kansas City, Mo.*
Marsh, George William, Jr.,	Kincaid.
Means, Boyd Irwin,	Arkansas City.
Melvin, Laighton Russell,	Iola.
Miller, Frank Herbert,	Clay Center.
Miltner, Elmo Franklin,	Wichita.
Murphy, Willard David,	Lawrence.
McCune, Malcolm,	Leavenworth.
McFadden, Roy True,	Salina.
McKnight, Harry Ray,	Cherryvale.
Nelson, Stanley Barrows,	*Paris, Tex.*
Nutting, Floyd Lester,	Russell.
Orton, James Wilbur,	*Centerville, Mo.*
Painter, Charles Jesse,	Barclay.
Payne, Carmen Green,	Olathe.
Pierce, Norman Jean,	White Cloud.
Pinkerton, Howard King,	Olathe.
Potter, Orrin Thomas,	*Sapulpa, Okla.*
Putnam, Glen Harold,	Lawrence.
Rader, Valentine Simpson,	Lawrence.
Ruth, Oren H.,	Moundridge.
Rutherford, Lawrence Winfield,	Douglass.
Sammons, George Benjamin,	Sabetha.
Sanders, Earl Russell,	Lawrence.
Scaggs, Claude Albertine,	Winona.
Schmidt, Karl W.,	*Kansas City, Mo.*
Schooley, Emmet Franklin,	*Kansas City, Mo.*
Seibert, John Franklin.	Augusta.
Spangler, Karl Bauman,	Lawrence.
Sterling, Allen,	Lawrence.
Strachan, Norman Fraser,	Eudora.
Sweeney, Ben A.,	*Kansas City, Mo.*
Tait, Ralph Shannon,	Fort Scott.
Templin, Richard Lawrence,	Minneapolis.
Tobin, Clarence Lewis,	Frankfort.
Truesdell, Sidney Augustus,	Wathena.

SOPHOMORES—*concluded.*

Wade, Hugh Reese,	*Kansas City, Mo.*
Walker, Roy Melvin,	Lawrence.
Weibel, Leo N.,	Lawrence.
Welch, Erroll Meredith,	*Cashion, Okla.*
Whitten, Willis George,	Marysville.

SOPHOMORES, 88

FRESHMEN.

Ackers, Deane Emmett,	Abilene.
Adams, Merle,	Perry.
Alt, Glenn Leslie,	Denton.
Ammons, Olly Cecil,	Arkansas City.
Anderson, Carl Edward,	Kansas City.
Archer, Ralph,	Garnett.
Arnold, Ernest,	Cottonwood Falls.
Baer, Carl Toevs,	Moundridge.
Baird, Hugh Edwin,	Formoso.
Bartell, Albert Raymond,	Wakefield.
Beckley, Drew Trout,	Lawrence.
Benson, Thatcher Wyllys,	Independence.
Bohannon, Hillory,	Glasco.
Bost, Frank Noel Orr,	Douglass.
Buckles, Robert William,	*Kansas City, Mo.*
Burt, Archie Ray,	Blue Mound.
Burton, Willard Augustus,	Mound City.
Campbell, Samuel Erle,	Meade.
Cantrell, Lorraine Vivian,	Pittsburg.
Caplinger, Robert Franklin,	Hutchinson.
Carter, Alva Bruce,	Lawrence.
Chandler, Harold Lyman,	Parsons.
Chaves, Galer Millard,	Atchison.
Chrisman, Joseph,	*Independence, Mo.*
Clarke, Stewart,	Marysville.
Clayton, Ross Herbert,	Hill City.
Clover, Earl Lister,	Humboldt.
Cole, Lawrence Eduard,	Lawrence.
Coolbaugh, Charles William,	Stockton.
Cort, Marcus Robert,	Kansas City.
Dahlgren, Earl William,	Kansas City.
Daum, Merrill Freeland,	Lawrence.
David, Clyde Isaac,	Crystal Springs.
Davis, Guy Foster,	Lawrence.
Deewall, Raymond Gregory,	Argonia.
Denton, Roy Steve,	Humboldt.
Diehl, Paul Adam,	Peck.
Dorsey, Eli Farrell,	Lawrence.
Durland, Harry Johnston,	Centralia.
Duvall, Eugene Norlin,	Hutchinson.
Elmore, Frank Baugh,	Lyndon.
Evans, Jesse Melvin,	Pleasanton.
Finch, Floyd Pierce,	Lawrence.
Fishback, James Orville,	Emporia.
Fiske, Leland Emberson,	*Kansas City, Mo.*
Flagg, George Horace,	Pleasanton.
Fletcher, Claude Charles,	Glasco.
Freienmuth, Ernest Edward,	Tonganoxie.
Fuller, Alvar Wendell,	Salina.
Gearhart, Walter Russell,	Englewood.
Gleadall, Joe,	Hutchinson.
Goldtrap, Walter Arthur,	Lawrence.
Hall, Thomas Newton,	Emporia.
Hammond, John Isaac,	Towanda.
Hawkins, George,	Coffeyville.
Henry, Howard F.,	Lecompton.
Herrod, Richard Alan,	*Webb City, Mo.*

FRESHMEN—*continued.*

Hite, Oral Lee,	Lawrence.
Hunt, James Lee,	Kansas City.
Jackson, James Edwin,	Clements.
James, Darley Shively,	Lawrence.
Jellison, Arthur Asa,	Wilson.
Johnson, Francis Louis,	Russell.
Julien, Charles LeRoy,	Wamego.
Kane, Herbert Warren,	Lawrence.
Lawyer, Elmer Julius,	Iola.
Machovec, Edward Paul,	*Kansas City, Mo.*
Madden, Frank Augustus,	Abilene.
Manley, Marion,	Junction City.
Maris, Clyde,	Stockton.
Martin, Dan Curtis,	*Fort Morgan, Colo.*
Matteson, Walter William,	*Nowata, Okla.*
Meredith, Wayland Halteman,	*Joplin, Mo.*
Miller, John Adelbert, Jr.,	Coffeyville.
Moore, William Austin,	Topeka.
Morton, Thomas Q.,	Atchison.
Moses, Owen Clifford,	Maple Hill.
Moyer, Samuel Parkhurst,	Blue Rapids.
Murphy, Robert Cleveland,	*Independence, Mo.*
McNeil, Frederick,	Bonner Springs.
Neal, Gay,	Anthony.
Neal, Roy Orley,	Independence.
Nelson, Alfred Kibler,	Iola.
Newcomer, Earl Thomas,	*Kansas City, Mo.*
Newton, Verne Thomas,	Winfield.
Nicolay, Carl Louis,	Abilene.
Nicolet, Arthur Coombs,	*Kansas City, Mo.*
Paul, Homer Harrison,	Augusta.
Pickering, Walter Roscoe,	Galena.
Raemer, Fred William,	Herkimer.
Rambo, Carl Wilson,	Arkansas City.
Rathert, George August,	Junction City.
Rhoads, Earl Newton,	Andale.
Riley, William Stillman,	Garnett.
Romick, John Henry,	Maple Hill.
Rush, Lowell Lee,	*Kansas City, Mo.*
Russell, Frank Liscum,	Lawrence.
Russell, Harlan Arthur,	Lawrence.
Russell, George Raymond,	Rosedale.
Samson, Henry Ernest,	Quinter.
Shade, David George,	Kansas City.
Sharp, John Beyard,	Topeka.
Smee, George Reezin,	Wa Keeney.
Smith, Gail Arthur,	Great Bend.
Smith, Joseph P., Jr.,	*Kansas City, Mo.*
Smith, Leo Frisly,	Larned.
Stead, George Allen,	Calista.
Stevens, Harry M.,	Lawrence.
Stillwell, Jerry Edward,	Erie.
Stotts, Glen P.,	Yates Center.
Stryker, Wilburn,	Fredonia.
Sunderland, Elmer James,	*Kansas City, Mo.*
Sykes, Clifford Burton,	Murdock.
Templin, Arthur W.,	Minneapolis.
Turkington, Victor Howard,	Cherokee.
Tustin, Robert Thomas,	*Clayton, Idaho.*
VanDerlip, Clyde Leroy,	Ottawa.
Vawter, Rufus Lloyd,	Coffeyville.
Wagner, Page Paschal,	Concordia.
Wakefield, Claude Hammond,	Anthony.
Wegner, Walter Kurt,	Onaga.
Welch, Clarence Vawter,	Edna.
Wheelock, Harold Eugene,	*Kansas City, Mo.*

FRESHMEN—*concluded.*

Wickstrum, Arthur Stephen,	*Independence, Mo.*
Williams, Ira,	Wilson.
Wright, Kenneth W.,	Fort Scott.

FRESHMEN, 126

SPECIALS.

Bennett, James Leroy,	*Carthage, Mo.*
Brooks, Leo Stanley,	Mound City.
Campbell, Louis Jasper,	Lawrence.
Covalt, William Benjamin,	Mound Valley.
Heidenreich, Edwin Lee, Jr.,	*Kansas City, Mo.*
Hodgins, William Tottenham,	Topeka.
Madden, Milton Finney,	Topeka.
Meyn, Fred Otto,	Kansas City.
Pike, Harry F.,	Fall River.
Poland, Clare Archie,	Atchison.
Preston, Joe Bradford,	Kansas City.
Smith, Lewis Benedict,	Lawrence.

SPECIALS, 12

Enrollment, 1912-'13.

SCHOOLS.	MEN.	WOMEN.	TOTAL.
The Graduate School	77	42	119
The College of Liberal Arts and Sciences	713	574	1,287
Senior Class	86	118	204
Junior Class	107	114	221
Sophomore Class	130	112	242
Freshman Class	292	183	475
Specials	98	47	145
School of Engineering	391	1	392
Senior Class	76	......	76
Junior Class	90	......	90
Sophomore Class	88	......	88
Freshman Class	125	1	126
Specials	12	......	12
The School of Fine Arts	11	150	161
Senior Class	......	17	17
Junior Class	1	25	26
Sophomore Class	1	18	19
Freshman Class	2	26	28
Specials	7	64	71
The School of Law	214	1	215
Senior Class	61	......	61
Middle Class	75	1	76
Junior Class	71	......	71
Specials	7	......	7
The School of Pharmacy	77	1	78
Senior Class	24	......	24
Junior Class	49	......	49
Sophomore Class	3	1	4
Specials	1	......	1
The School of Medicine	65	24	89
Fourth Year	6	1	7
Third Year	10	1	11
Second Year	16	1	17
First Year	30	1	31
Specials	3	......	3
Nurses	......	20	20
The School of Education	60	202	262
Graduates	10	7	17
Seniors	27	84	111
Juniors	18	77	95
Specials	5	34	39
Total enrollment, regular session	1,608	995	2,603
Names counted twice	140	201	341
	1,468	794	2,262
The Summer Session	221	247	468
Current students in Summer Session	94	90	184
	127	157	284
TOTAL REGISTRATION, 1912-'13	1,595	951	2,546

Classification of Students.

BY KANSAS COUNTIES.

Allen	28
Anderson	17
Atchison	26
Barber	9
Barton	11
Bourbon	31
Brown	25
Butler	22
Chase	1
Chautauqua	4
Cherokee	29
Clark	8
Clay	18
Cloud	20
Coffey	10
Cowley	37
Crawford	28
Decatur	9
Dickinson	41
Doniphan	23
Douglas*	695
Edwards	10
Elk	8
Ellis	5
Ellsworth	14
Finney	6
Ford	11
Franklin	31
Geary	14
Gove	1
Graham	3
Greenwood	16
Harper	8
Harvey	31
Haskell	2
Jackson	16
Jefferson	13
Jewell	10
Johnson	37
Kingman	12
Labette	30
Lane	3
Leavenworth	44
Lincoln	8
Linn	31
Logan	5
Lyon	27
Marion	20
Marshall	31
McPherson	36
Meade	5
Miami	14
Mitchell	2
Montgomery	40
Morris	6
Nemaha	29
Neosho	23
Ness	9
Norton	7
Osage	22
Osborne	6
Ottawa	10
Pawnee	7
Phillips	4
Pottawatomie	17
Pratt	6
Rawlins	1
Reno	51
Republic	14
Rice	21
Riley	3
Rooks	7
Rush	6
Russell	13
Saline	19
Scott	1
Sedgwick	66
Seward	1
Shawnee	48
Sheridan	3
Smith	9
Stafford	11
Sumner	26
Thomas	4
Trego	6
Wabaunsee	16
Wallace	3
Washington	25
Wichita	1
Wilson	22
Woodson	5
Wyandotte	100

BY STATES.

Arkansas	3
California	2
Colorado	11
Idaho	1
Illinois	3
Indiana	1
Iowa	3
Kansas	2,264
Louisiana	1
Massachusetts	1
Mexico	1
Michigan	1
Missouri	191
Montana	1
Nebraska	6
New Mexico	3
New York	1
Ohio	1
Oklahoma	42
Oregon	1
Pennsylvania	1
Tennessee	1
Texas	2
Utah	1
Virginia	2
Wisconsin	1
	2,546

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* A large number of students whose names appear in this catalogue as residents of Douglas county are so catalogued because they temporarily reside in Lawrence for the purpose of attending the University.

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1914/15

THE
UNIVERSITY OF KANSAS

ANNUAL CATALOG

1914-1915

ENGINEERING SCHOOL

SECTION IV

UNIVERSITY OF ILLINOIS LIBRARY
AUG 17 1917

Bulletin of University of Kansas, Vol. 16, No. 8, March 1, 1915

Entered as second-class matter December 29, 1910, at the post office at Lawrence, Kansas, under act of July 16, 1894.

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- V. School of Fine Arts.
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- VII. School of Pharmacy.
- VIII. School of Medicine.
- IX. School of Education.
- X. Summer Session.
- XI. Extension Division.
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THE
UNIVERSITY OF KANSAS

ANNUAL CATALOG

1914-1915

SCHOOL OF ENGINEERING
SECTION IV

UNIVERSITY CALENDAR.

Academic Year, 1914-'15.

January 1, Friday—Close of Christmas recess.
February 1 to 5, Monday to Friday, inclusive—Semester examinations.
February 8, Monday—Beginning of second semester.
February 12, Friday, Lincoln's birthday—Legal holiday.
February 22, Monday, Washington's birthday—Legal holiday.
April 2 and 5, Friday and Monday—Easter recess.
April 5, Monday—Beginning of second half-semester.
May 31 to June 4, Monday to Friday, inclusive—Semester examinations.
June 6, Sunday, 8 p. m.—Baccalaureate sermon.
June 7, Monday, 8 p. m.—Organ recital.
June 8, Tuesday, 8 p. m.—Chancellor's reception.
June 9, Wednesday, 10 a. m.—Commencement exercises.
June 10, Thursday—Beginning of Summer Session.

Academic Year, 1915-'16.

September 13, Monday—Entrance examinations and registration.
September 14, 15, Tuesday, Wednesday—Enrollment in classes.
September 16—Beginning of class work in all departments.
September 17, Friday—General assembly and annual address, at 10 a. m.
November 22, Monday—Beginning of second half-semester.
November 25, 27, Thursday to Saturday—Thanksgiving recess, beginning Wednesday noon.

CHRISTMAS RECESS—Saturday, December 18, to Saturday, January 1, inclusive.

January 24 to 28, Monday to Friday, inclusive—Semester examinations.
January 31, Monday—Beginning of second semester; enrollment in classes.
February 1, Tuesday—Beginning of class work in all departments.
February 22, Tuesday, Washington's birthday—Legal holiday.
April 3, Monday—Beginning of second half-semester.
April 21 to 24, Friday to Monday—Easter recess.
May 29 to June 2, Monday to Friday, inclusive—Semester examinations.
May 30, Tuesday, Decoration Day—Legal holiday.
June 4, Sunday, 8 p. m.—Baccalaureate sermon.
June 5, Monday, 8 p. m.—Organ recital.
June 6, Tuesday, 10:30 a. m.—Alumni address.
June 6, Tuesday, 8 p. m.—Chancellor's reception.
June 7, Wednesday, 10 a. m.—Commencement exercises.
June 8, Thursday—Beginning of Summer Session.

STATE BOARD OF ADMINISTRATION OF EDUCATIONAL INSTITUTIONS.

Mr. ED. T. HACKNEY, *President,* Wellington..... Term expires 1917
Mr. EDWARD W. HOCH, Marion................ Term expires 1919
Mrs. J. M. Lewis, Kinsley......................... Term expires 1917
Mr. D. M. Bowen, *Secretary,* Pittsburg.

FACULTY.

Frank Strong, Ph. D., Chancellor of the University, and President of the Faculties.

Perley F. Walker, M. M. E., Dean of the School of Engineering, and Professor of Mechanical Engineering.

Frank O. Marvin,[1] A. M., Emeritus Dean of the School of Engineering.

Edgar Henry Summerfield Bailey, Ph. D., Professor of Chemistry and Metallurgy, and Director of Chemical Laboratories.

Charles Graham Dunlap, Litt. D., Professor of English Literature.

Erasmus Haworth, Ph. D., Professor of Geology, Mineralogy, and Mining, and Superintendent of the Geological Survey.

William Chase Stevens, M. S., Professor of Botany.

William Alexander Griffith, Professor of Drawing and Painting.

Eugenie Galloo, A. M., Professor of Romance Languages and Literatures.

James Naismith, M. D., Professor of Physical Education.

George Carl Shaad, E. E., Professor of Electrical Engineering.

Frederick Edward Kester, Ph. D., Professor of Physics.

Hamilton Perkins Cady, Ph. D., Professor of Chemistry.

B. J. Dalton,[2] B. C. E., Professor of Railway Engineering and Surveying.

Harry Alvin Millis, Ph. D., Professor of Economics.

Henry Wilbur Humble, A. M., Professor of Law.

Herbert Allen Rice, C. E., Professor of Mechanics and Structural Engineering.

Goldwin Goldsmith, Ph. B., Professor of Architecture.

Clement C. Williams, C. E., Professor of Railway Engineering.

Frank Burnett Dains, Ph. D., Professor of Chemistry.

Martin Everett Rice, M. S., Associate Professor of Physics and Electrical Engineering.

Clinton M. Young,[3] E. M., Associate Professor of Mining Engineering.

Charles Hamilton Ashton, Ph. D., Associate Professor of Mathematics.

George Jussen Hood, B. S., Associate Professor of Mechanical Drawing.

William Asbury Whitaker, Jr., A. M., Associate Professor of Metallurgy.

F. H. Sibley, M. E., Associate Professor of Mechanical Engineering.

Charles A. Haskins, B. S., Associate Professor of Sanitary Engineering.

Frederick Newton Raymond, A. M., Associate Professor of Rhetoric.

Herman Camp Allen, A. M., Associate Professor of Chemistry.

Clarence Anthony Johnson, B. S., Associate Professor of Electrical Engineering.

William Coleman McNown, B. S., Associate Professor of Civil Engineering.

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[1] Died February 6, 1915.

[2] On leave of absence.

[3] On leave of absence during first semester. Resigned December, 1914.

E. S. DICKINSON,[4] E. M., Associate Professor of Mining.

EDWIN FISKE STIMPSON, B. S., Assistant Professor of Physics.

CHARLES COCHRAN, B. S. in M. E., Assistant Professor of Mechanical Drawing.

FRANK EVERETT JONES, Assistant Professor of Pattern Making and Founding.

ALFRED HIGGINS SLUSS, B. S. in M. E., Assistant Professor of Mechanical Engineering.

CLIFFORD CAUDY YOUNG, M. S., Assistant Professor of Chemistry.

HERBERT E. JORDAN, Ph. D., Assistant Professor of Mathematics.

THEODORE TOWNSEND SMITH, A. M., Assistant Professor of Physics.

PAUL VANCE FARAGHER, Ph. D., Assistant Professor of Chemistry.

FRED REDDER HESSER, B. S., Assistant Professor of Sanitary Engineering.

JOHN DILLER GARVER, B. S., Assistant Professor of Mechanical Engineering.

FRANK LOGAN BROWN, B. S., Assistant Professor of Mechanics.

EDWARD MAURICE BRIGGS, A. M., Assistant Professor of German, and University Marshal.

CALVERT JOHNSON WINTER, Ph. B., Assistant Professor of Romance Languages.

H. A. ROBERTS, B. S., Assistant Professor of Civil Engineering.

JOSEPH E. WELKER, M. of C. E., Assistant Professor of Sanitary Engineering.

MAY GARDNER, A. B., Instructor in Romance Languages.

JOHN JEFFERSON WHEELER, A. B., Instructor in Mathematics.

HUBERT WILTFONG, Instructor in Forging.

WORTH HUFF RODEBUSH, A. B., Instructor in Chemistry.

LEON B. MCCARTY, A. M., Instructor in Rhetoric.

SARA G. LAIRD, A. B., Instructor in Rhetoric.

SOLOMON LEFSCHETZ, Ph. D., Instructor in Mathematics.

W. W. HAWKINS, A. M., Instructor in German.

SYLVESTER SPARKS SCHOOLEY, B. S., Instructor in Electrical Engineering.

HENRY HERMAN CONWELL, B. S., Instructor in Mathematics.

HERMAN ADOLPH LORENZ, Instructor in Physical Education.

OSCAR ROCKLUND, Mechanician and Assistant Instructor in Foundry.

WILLIAM H. SEVERNS, B. S., Assistant Instructor in Mechanics.

GEORGE BELCHIC, B. S., Assistant Instructor in Mining Engineering.

DANIAL HAZEN, B. S., Assistant Instructor in Drawing.

ADMINISTRATIVE COMMITTEE.

P. F. WALKER, *Chairman.*	H. A. RICE.
C. H. ASHTON, *Secretary.*	G. GOLDSMITH.
E. HAWORTH.	M. E. RICE.
G. C. SHAAD.	W. A. WHITAKER.

G. J. HOOD, *Chief Adviser of Freshmen.*

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[4] For 1914-'15.

School of Engineering.

ORGANIZATION AND PURPOSE.

The School of Engineering was organized as a distinct school of the University in 1891. Prior to that time, for eighteen years, courses in engineering had been given under the collegiate department, mainly in the civil and electrical branches.

Technical work is given in eight departments, entirely within the control of the School. Departments of the College of Liberal Arts give courses in science, mathematics, language, and economics for engineering students. The curriculum includes definitely scheduled work leading to degrees in the main branches of engineering—civil, electrical, mechanical, mining, chemical, and architectural—with options under the civil in railway, structural and sanitary engineering. Provision is made also for those who desire a training for business and administrative work based upon engineering.

The requirements for graduation emphasize the fact that a thorough grounding in the fundamental sciences, mathematics and language is essential to successful engineering practice. This idea is then extended by introducing a moderate amount of specialized work in the Junior and Senior years, but the aim throughout is to develop the principles underlying technical engineering work rather than to make direct applications. It will be observed, moreover, that the requirements for graduation call for about twenty credit hours more than are required for a degree in pure science or arts, and this excess is in the nature of practice work in shop, field and drawing room. By these three methods the purpose of the School is shown, namely, to give the basis of a liberal education while providing for training in specialized professions, and to give sufficient practice work and familiarity with operating methods to enable the graduate to make himself useful to employers while he is gaining the broader experience necessary to a successful engineering career.

In order to give greater emphasis to the value of general educational training for engineers, provision has been made for students so desiring to spend one year in the College of Arts and Sciences, and then to enter the School of Engineering for four years of study, making up a total of five years in the University. The conditions under which this may be done, and statements as to the degree conferred on completion of the work, are given in the following pages. The amount of technical work required is the same as in the regular four-year courses, but opportunities are offered for selecting a wider range of studies, and so providing for a broader education. Young men just graduating from high school are strongly urged to adopt this plan of procedure.

The leading characteristics of the several branches are noted in the following outlines:

Civil Engineering.

In the professional work emphasis is laid on surveying and field methods; on mechanics and the application to the designing of steel and concrete structures; on railway location and construction; on hydraulics, and the application to irrigation, canal and power work; and on water supply and other municipal problems, including pavement and highway construction. Particular emphasis is given to the training of men for the three important branches, namely, railway, structural, and sanitary engineering. For each of these a special schedule for the work of the Senior year will be found in the following pages.

Electrical Engineering.

The specialized studies under this heading follow the fundamental work in physics and machine elements. They give emphasis to the methods of design, construction and operation of electrical equipment of all kinds as employed for the production, distribution and application of electrical energy, and in telephone service. Much emphasis is laid on the fundamental principles of mechanics and of electricity, and on laboratory practice in handling standard apparatus. Original investigation is encouraged in every way possible.

Mechanical Engineering.

In the professional work especial emphasis is placed on machine construction and design, the properties of materials, power generation with heat engines, and general manufacturing methods. Options in the Senior year permit specialization to a limited degree, so that the student may give his attention to that line in which he develops the greatest interest. The aim is to give the training which will permit the graduate to perform successfully the work required of the technical designer and administrator in manufacturing industries.

Mining Engineering.

In this branch professional work depends more directly upon chemistry and geology, and more work is required in these fundamentals than in the other branches already mentioned. Following this the professional work is of two kinds—first, that which bears upon the actual development and operation of mines, including the methods of administration; second, that which bears upon the treatment of the mine product in the various milling and smelting processes. It is the aim to emphasize the scientific principles involved, and so make it possible for the graduate to begin his later specialization successfully in any one of the many lines of work within the broad range of the mining industry.

Chemical Engineering.

In this branch opportunity is given for specialization in technical chemistry, with the aim to combine the ability to perform chemical work with training in the fundamentals of engineering. It is expected that students are fitting themselves for positions as chemists and superintendents of manufacturing plants where the work is based on chemical science. These include many industries, such as those involving iron and steel, smelting, refining, bleaching and dyeing processes, and the manufacture of many specialized products.

Architectural Engineering.

Much is included in this branch which involves the artistic as well as the utilitarian in building design and construction. It is recognized that architecture is essentially a fine art, but that this should be combined with the scientific and technical training which will enable the graduate to deal with the engineering side of construction work. The professional work given includes thorough instruction in the history and theory of architecture and in the principles of design. It is the aim to give such training as will enable the graduate to render efficient service while he is supplementing his school training by experience gained in office practice.

Engineering and Administrative Science.

Arrangements have been perfected recently whereby the College departments of economics, history and sociology coöperate with the School of Engineering in offering work to fit men for positions in the administrative offices of manufacturing companies and in the transportation departments of railroads. Both the college student and the engineering student may profit by the plan.

The student who has started in engineering may begin to vary the regular schedule of studies during his second year, and may, under the advice of a committee of the Faculty, arrange to substitute from twenty to twenty-five hours of courses in the College departments indicated in place of the more highly specialized engineering work. The student is trained, therefore, in all the fundamentals of engineering, and should be well fitted to take positions in offices where the work depends largely upon technical phases of the industry in question. A more detailed statement of the work will be found in the following pages under the heading "Curriculum."

DEGREES GRANTED.

All graduates of the School of Engineering are admitted to the degree of bachelor of science in engineering or bachelor of science. The first is given to those who have completed the work laid out on the regular four-year plan, based on entrance from the accredited high schools. The second is given to those who enter the School of Engineering after having completed thirty hours of work in the College of Arts and Sciences, and to those who complete the work offered in engineering and administrative science.

All graduates of the School of Engineering may enter the Graduate School of the University and become candidates for the degree of master of science under the regulations there in force.

Graduates in engineering from this University, and those who have received the master's degree through the Graduate Faculty, are eligible to the professional degrees of Civil Engineer, Electrical Engineer, Mechanical Engineer, Engineer of Mines, Chemical Engineer, and Architectural Engineer, whichever is appropriate to the undergraduate work taken. Candidates for these degrees must have spent at least three years of actual time in professional practice in positions of responsibility, in the design, construction, or operation of professional works, and must furnish detailed and satisfactory evidence as to the nature and extent of this practice.

The candidate must submit a thesis, accompanied by detailed explanations, drawings, specifications, estimates, etc., and embodying the results of his own work or observation. If approved, the thesis, with all accompanying material, becomes the property of the University.

The thesis for any professional degree must be delivered to the Dean of the School of Engineering on or before May 15.

ADMISSION.

By act of the state legislature, all graduates of accredited high schools in Kansas are admitted to the Freshman class without examination or condition.

Graduates of other preparatory schools will be admitted on such conditions as the Faculty may impose.

For the guidance of prospective students who desire to prepare themselves as well as possible, an outline of preparatory studies which has been followed for many years is given below. A total of fifteen units must be offered for admission.

ENGLISH.—Rhetoric and English literature, 3 or 4 units. Three units required.

MATHEMATICS.—Elementary Algebra, 1½ units; plane geometry, 1 unit; solid geometry, ½ unit; plane trigonometry, ½ unit; advanced algebra, ½ unit. Three units required to prepare for the regular engineering courses.

FOREIGN LANGUAGES.—Latin, 1, 2, 3 or 4 units; Greek, 1, 2, 3 or 4 units; German, 1, 2, 3 or 4 units; French, 1, 2, 3 or 4 units; Spanish, 1 or 2 units. Two units at entrance and ten hours of German, French or Spanish in the University complete the requirements for graduation. If a student presents over three units for entrance, one or more being in modern language, he may substitute other work for a portion of the language regularly required in the School of Engineering.

PHYSICAL SCIENCES.—Physical geography, 1 or ½ unit; physics, 1 unit; Chemistry, 1 unit. One unit required.

BIOLOGICAL SCIENCES.—Botany, 1 unit; zoölogy, 1 unit; physiology, 1 or ½ unit; biological science, 1 unit.

HISTORY AND SOCIAL SCIENCE.—Greek and Roman history, 1 unit; medieval and modern history, 1 unit; English history, 1 unit; American history, 1 unit; economics, 1 or ½ unit; civics, ½ unit. Three units recommended.

MANUAL TRAINING.—Woodwork, forging, and machine tool work, 2 units; freehand or mechanical drawing, 1 unit.

MISCELLANEOUS.—Stenography, ½ unit; bookkeeping, ½ unit; commercial law, ½ unit; commercial geography, ½ unit; agriculture, ½ or 1 unit; psychology, ½ unit; advanced arithmetic if taken after one year of algebra, ½ unit. Not more than two units are allowed.

Entrance Examinations.

Candidates for admission who are not graduates of accredited Kansas high schools may offer themselves for examinations in subjects usually embraced in the high-school curriculum. Whenever a candidate has thus secured credit for the equivalent of the work included in the curriculum of the accredited high school he will be admitted to the Freshman class.

A schedule of these examinations will be found on page 47 of the General Information section of the Catalog.

Inadequate Preparation.

When a student by his current work shows insufficient preparation for any course, he may be required to make good such deficiency in any manner prescribed by his instructor and approved by the Dean of the School.

Admission to Advanced Standing.

For an advanced rank, the applicant must have completed all of the courses of the curriculum below the rank for which he applies, including the entrance requirements or their substantial equivalent, as determined by the committee on advanced standing. Application for credits toward advanced standing should be made to the Dean of the School of Engineering.

Credit in Foreign Language.

Advance credit for work in preparatory schools will be given upon examination only, except for the following provisions in foreign language: High-school graduates presenting four units in not more than two foreign languages, one of these being a modern language, will be allowed to substitute five hours of optional subjects in the University for five hours of the regularly required modern language. This means that such students are to continue the study of the same modern language as that offered for entrance, during the first semester of the Freshman year. When presenting five or more units in not more than two foreign languages, two of these units being in a modern language, they will be allowed to substitute ten hours of optional courses for the ten hours of modern language regularly required. The choice of these optional courses shall be subject to the approval of the students' adviser and the Dean of the School of Engineering.

Special Students.

Opportunity is given in the School of Engineering for the admission of persons of mature years who desire to pursue some special lines of work, without following any prescribed course of study or becoming candidates for a degree.

The admission of such special students is directly under the control of the Dean of the School of Engineering, whose certificate of acceptance must be presented to the Registrar before registration. Applicants for admission as special students must present satisfactory evidence of proper preparation for the courses desired, and must also meet other requirements as fixed by the Faculty.

Special students are subject to the same regulations as are regular students with regard to the quality of work performed and attendance at recitations and examinations, but not as to number of courses to be pursued.

REGISTRATION.

All candidates for admission having certificates from accredited schools and all students of the University intending to pursue their studies during the ensuing year must present themselves for registration at the University on September 13, 14 or 15, 1915. Registration at a later date will be permitted only on the payment of a fee of one dollar.

ENROLLMENT.

After registration has been completed with the Registrar and fees have been paid, students should apply to the Dean for enrollment in their classes. Enrollment the first semester occurs September 14 and 15, 1915, and on the first day of the second semester. Enrollment at a later date will be permitted only on the payment of a fee of one dollar.

FEES AND EXPENSES.

Matriculation fee, for residents of the state	$5.00
for nonresidents	10.00
Incidental fee per school year, for residents of the state	10.00
for nonresidents	20.00
Diploma fee, at graduation	5.00

Cost of Materials.

In all laboratory and shop courses the student is charged for the materials and supplies he consumes in his work. These charges are payable in advance at the office of the University Registrar by the purchase of a book of coupons receivable for materials in any course, or by the payment of a fixed amount for a course in which the material can not be issued to each student individually. A schedule of these fixed fees, varying from 50 cents to $4, is posted in Marvin Hall and in the office of the University Registrar. In those courses where a large amount of material is used by the student and paid for with coupons, the total cost for any one course may reach or occasionally exceed $10.

Those students taking summer field work will be charged the actual cost of living and incidental expenses.

Expense for Inspection Trips, etc.

Students should make provision for expenses of about $40 in the Junior or Senior year, or both, for inspection trips to engineering works. (See "Inspection Trips" at the end of "Description of Courses.")

ENGINEERING EXTENSION WORK.

CORRESPONDENCE COURSES.

Through the University Extension Division the School of Engineering offers work by correspondence. By this method it is possible for a student to secure instruction in many of the general courses required for the degree in engineering and in a few of the technical courses.

In cases where a group of six or more persons may be formed, arrangements have been made whereby the Extension Division will send an instructor at stated intervals to meet the class. By this means many of the technical courses are being offered which are not offered directly through correspondence. An additional fee is required for work thus given. In this manner it is possible for young men to do a large portion of the work required for a degree, but the School of Engineering requires that at least one year of work shall be done in residence.

Work is being offered also of a grade below that required for regular credit, in what are termed Vocational Courses. By means of these courses, effort is made to extend the facilities of the University to a large group of young men who have not had time or opportunity to fit themselves for regular engineering work. When possible the work is carried on in coöperation with the school authorities of cities and towns and with industrial organizations which employ boys in considerable numbers.

For further details, see "University Extension Division."

TECHNICAL SOCIETIES.

TAU BETA PI. Kansas Alpha Chapter of the honorary engineering society of Tau Beta Pi was installed in December, 1914. Members are from the Senior and Junior classes, chosen under regulations which require that all who are elected shall have standing in the upper fourth of their class during the Senior year. It is governed entirely by undergraduates.

Departmental Student Societies.

In each of the six departments in which a complete course of study leading to graduation is scheduled there is a well-organized society holding regular meetings at weekly or biweekly intervals. At these meetings technical addresses are given or topics from the current press discussed. The architectural, chemical and civil engineering societies are local in their character. The electrical, mechanical and mining organizations are connected with the respective national engineering societies. More detailed information is given on page 43 of the General Information Section of the Catalog.

CURRICULUM.

Leading to the Degree of Bachelor of Science in Engineering.

The work required for the degree of bachelor of science in the School of Engineering is in large measure prescribed. The following schedules show the variations among the several branches. Students are required to enroll for the work in the order given, excepting a few of the specialized courses in the Junior and Senior years, which do not depend directly on preceding courses.

The work of the Freshman year is very nearly the same for all students, so that a choice among the several branches need not be made at the start, excepting in the case of architectural engineering. A slight modification of the shop courses in machine construction makes it desirable for those planning to take civil and mining engineering to make definite decision at the end of the first semester.

COURSES COMMON TO ALL LINES.

FRESHMAN YEAR.

FIRST SEMESTER, 17 credit hours.*

Course number.	*Subject.*	*Credit hrs.*
Mathematics 2	College Algebra	3
Mathematics 3	Plane Trigonometry	2
German, French or Spanish†	(Course as approved)	5
English 1 E	Rhetoric I	3
Engineering Drawing 1	Free-hand Drawing	1⅓
Engineering Drawing 2	Mechanical Drawing	⅔
Engineering Drawing 4, or Machine Construction 1 and 2	Machine Drawing, or Foundry Practice and Pattern Making	2
Engineering 1	Engineering Lectures.	
Physical Education 1	Gymnasium, 3 periods per week.	

SECOND SEMESTER, 17 credit hours.

Course number.	*Subject.*	*Credit hrs.*
Mathematics 4E	Analytic Geometry	5
German, French, or Spanish†	(Course as approved)	5
English 2 E	Rhetoric II	2
Engineering Drawing 3	Descriptive Geometry	3
Engineering Drawing 4, or Machine Construction 1 and 2, or Machine Construction 3 and 4	Machine Drawing or Foundry, Forge and Machine Shop Practice as assigned	2
	Gymnasium, 3 periods per week.	

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* THE CREDIT HOUR.—The amount of work required to complete a course is measured in "credit hours." One credit hour in the School of Engineering represents an amount of work which is estimated to require three hours per week, throughout a semester, of the time of a student of average ability. These three hours may be divided in any ratio between class attendance and outside work, most courses being in the ratio of one hour in class to two hours of outside preparation; of two hours in class to one hour of outside preparation or report writing; or all three required in class with no outside preparation. In the descriptions of courses the number of credit hours for each is stated.

† The foreign language chosen is carried regularly throughout the year, five hours each semester. The selection of the language courses will depend on the amount and kind of language offered for entrance. Students offering more than three units for entrance may be allowed to substitute other nontechnical courses for the foreign language.

CIVIL ENINEERING.

SOPHOMORE YEAR.

FIRST SEMESTER, 18½ credit hours.

Course number.	*Subject.*	*Credit hrs.*
Civil Engineering 1	Surveying	3
Mathematics 5 E	Calculus I	5
Physics 1 E	General Physics	5
Geology 1	Elementary Geology	5
	Technical Report I	½

SECOND SEMESTER, 16½ credit hours.

Civil Engineering 4	Railway Surveying	2
Civil Engineering 1	Surveying	3
Mathematics 6 E	Calculus II	3
Physics 2 E	General Physics	5
Mechanical Engineering 5	Engines and Boilers	3
	Technical Report II	½

SUMMER WORK.

Civil Engineering 3	Field Work, 4 weeks.

JUNIOR YEAR.

FIRST SEMESTER, 18 credit hours.

Civil Engineering 55	Railway Surveying	4
Civil Engineering 51	Cartography	2
Mechanics 50	Mechanics	5
Chemistry 2	Advanced Inorganic Chemistry	4
English 50 E	Advanced Composition	3

SECOND SEMESTER, 17½ credit hours.

Civil Engineering 57	Railway Location	3
Mechanics 51	Strength of Materials	4
Mechanics 52	Testing Laboratory	1
Mechanics 53	Graphic Statics	2
Mechanics 55	Hydraulics	3
Mechanics 56	Hydraulic Laboratory	1
Chemistry 5 E	Engineering Chemistry	3
	Technical Report III	½

SENIOR YEAR.

FIRST SEMESTER, 17½ credit hours.

Civil Engineering 61	Stresses in Framed Structures	5
Civil Engineering 64	Masonry	2
Civil Engineering 65	Reinforced Concrete	3
Civil Engineering 70	Sanitary Engineering I	3
	Optional	3
	Thesis	1
	Technical Report IV	½

SECOND SEMESTER, 17 credit hours.

Course number.	*Subject.*	*Credit hrs.*
Civil Engineering 62	Bridge Design	4
Civil Engineering 75	Roads and Pavements	2
Engineering 52	Industrial Administration	3
Mechanics 57	Cement Laboratory	1
Civil Engineering 66	Reinforced Concrete Design	1
	Optional	4
	Thesis	2

One extended inspection trip is required during the Junior or Senior year.

Railway Engineering Option.

SENIOR YEAR.

FIRST SEMESTER, 18½ credit hours.

Civil Engineering 61	Stresses in Framed Structures	5
Civil Engineering 64	Masonry	2
Civil Engineering 65	Reinforced Concrete	3
Civil Engineering 70	Sanitary Engineering I	3
Civil Engineering 58	Railway Terminals and Signaling	2
Electrical Engineering 60	Elements of Electrical Engineering	3
	Technical Report IV	½

SECOND SEMESTER, 17 credit hours.

Civil Engineering 62	Bridge Design	4
Civil Engineering 75	Roads and Pavements	2
Mechanics 57	Cement Laboratory	1
Civil Engineering 59	Railway Construction and Maint.,	3
Engineering 52	Industrial Administration	3
Civil Engineering 66	Reinforced Concrete Design	1
	Thesis	3

Structural Engineering Option.

SENIOR YEAR.

FIRST SEMESTER, 18½ credit hours.

Civil Engineering 61	Stresses in Framed Structures	5
Civil Engineering 64	Masonry	2
Civil Engineering 65	Reinforced Concrete	3
Civil Engineering 70	Sanitary Engineering I	3
Mechanics 54	Engineering Materials	2
Electrical Engineering 60	Elements of Electrical Engineering	3
	Technical Report IV	½

SECOND SEMESTER, 17 credit hours.

Civil Engineering 62	Bridge Design	4
Civil Engineering 75	Roads and Pavements	2
Mechanics 57	Cement Laboratory	1
Civil Engineering 67	Higher Structures	3
Engineering 67	Industrial Administration	3
Civil Engineering 66	Reinforced Concrete Design	1
	Thesis	3

Municipal and Sanitary Option.

JUNIOR YEAR.

FIRST SEMESTER, 17 credit hours.

Course number.	*Subject.*	*Credit hrs.*
Civil Engineering 73	Sanitary Science	2
Mechanics 50	Mechanics	5
Chemistry 2	Advanced Inorganic Chemistry	4
English 50 E	Advanced Composition	3
Electrical Engineering 60	Electrical Engineering	3

SECOND SEMESTER, 17½ credit hours.

Civil Engineering 74	Waste and Garbage Disposal	1
Civil Engineering75	Roads and Pavements	2
Mechanics 57	Cement Laboratory	1
Mechanics 51	Strength of Materials	4
Mechanics 52	Testing Laboratory	1
Chemistry 3	Qualitative Analysis	4
Mechanics 55	Hydraulics	3
Mechanics 56	Hydraulic Laboratory	1
	Technical Report III	½

SENIOR YEAR.

FIRST SEMESTER, 18½ credit hours.

Civil Engineering 61	Stresses in Framed Structures	4
Civil Engineering 64	Masonry	2
Civil Engineering 70	Sanitary Engineering I	3
Civil Engineering 65	Reinforced Concrete	3
Chemistry 56 E	Water Analysis	5
	Thesis	1
	Technical Report IV	½

SECOND SEMESTER, 17 credit hours.

Engineering 52	Industrial Administration	3
Civil Engineering 72	Sanitary Design	5
Civil Engineering 71	Sanitary Engineering II	4
Civil Engineering 52	City Planning	2
Civil Engineering 66	Reinforced Concrete Design	1
	Thesis	2

One extended inspection trip is required during the Junior or the Senior year.

ELECTRICAL ENGINEERING.

SOPHOMORE YEAR.

FIRST SEMESTER, 17½ credit hours.

Course number.	*Subject.*	*Credit hrs.*
Mathematics 5 E	Calculus I	5
Physics 1 E	General Physics	5
Chemistry 2	Advanced Inorganic Chemistry	4
Mechanical Engineering 1	Machine Drafting	1
Machine Construction 3	Forging	1
Machine Construction 5	Bench Work	1
	Technical Report I	½

SECOND SEMESTER, 18½ credit hours.

Mechanical Engineering 3	Elementary Machine Design	3
Mechanical Engineering 4	Steam Machinery	2
Mathematics 6 E	Calcluus II	3
Physics 2 E	General Physics	5
Chemistry 3	Qualitative Analysis	4
Machine Construction 6	Machine Tool Work I	1
	Techincal Report II	½

JUNIOR YEAR.

FIFST SEMESTER, 17½ credit hours.

Electrical Engineering 50	Dynamo Machinery	3
Electrical Engineering 54	Electrical Laboratory	1½
Mechanics 50	Mechanics	5
Physics 52	Theory of Electricity	3
Physics 60 E	Electrical Measurements I	1½
Mechanical Engineering 52	Heat Engine Theory	3
	Technical Report III	½

SECOND SEMESTER, 18 credit hours.

Electrical Engineering 51	Theory of Alternating Currents	5
Electrical Engineering 55	Electrical Laboratory	1½
Mechanical Engineering 53	Mechanics of the Steam Engine	2
Mechanics 51	Strength of Materials	4
Mechanics 52	Testing Laboratory	1
English 50 E	Advanced Composition	3
Physics 61 E	Electrical Measurements II	1½

SENIOR YEAR.

FIRST SEMESTER, 17½ credit hours.

Electrical Engineering 52	Advanced Dynamo Machinery	5
Electrical Engineering 56	Advanced Electrical Laboratory	1½
Civil Engineering 50	Surveying	3
Mechanical Engineering 65	Power Laboratory	1½
Chemistry 64	Physical Chemistry I	5
	Thesis	1
	Technical Report IV	½

SECOND SEMESTER, 16½ credit hours.

Electrical Engineering 58	Electric Power Transmission	5
Electrical Engineering 57	Illuminating Engineering	2½
Engineering 52	Industrial Administration	3
Electrical Engineering 61	Thesis	3
	Optional	3

One extended inspection trip is required during the Junior or the Senior year.

MECHANICAL ENGINEERING.

SOPHOMORE YEAR.

FIRST SEMESTER, 18½ credit hours.

Course number.	*Subject.*	*Credit hrs.*
Mechanical Engineering 1	Machine Drafting	1
Mechanical Engineering 2	Mechanism	3
Mathematics 5 E	Calculus I	5
Chemistry 2	Advanced Inorganic Chemistry	4
Economics 1 E, or German, French, or Spanish	Elements of Economics, or (Advanced Language course as approved)	3
Machine Construction 3	Forging	1
Machine Construction 5	Bench Work	1
	Technical Report I	½

SECOND SEMESTER, 17½ credit hours.

Mechanical Engineering 6	Steam Engineering	4
Mathematics 6 E	Calculus II	3
Physics 1 E	General Physics	5
Chemistry 5 E	Engineering Chemistry	3
Machine Construction 6	Machine Tool Work I	2
Machine Construction 7	Machine Tool Work II	
	Technical Report II	½

JUNIOR YEAR.

FIRST SEMESTER, 18 credit hours.

Mechanical Engineering 51	Thermodynamics	3
Mechanical Engineering 64	Mechanical Laboratory	1
Physics 2 E	General Physics	5
Mechanics 50	Mechanics	5
Metallurgy 61 E	Metallurgy I	3
Machine Construction 8	Advanced Machine Shop Practice	1

SECOND SEMESTER, 16 credit hours.

Mechanical Engineering 50	Machine Design	4
Mechanical Engineering 54	Heating and Ventilation	2
Mechanical Engineering 60	Shop Methods	1½
Mechanics 51	Strength of Materials	4
Mechanics 52	Testing Laboratory	1
English 50 E	Advanced Composition	3
	Technical Report	½

SUMMER WORK.

Mechanical Engineering 68	Summer Vacation Work.	

SENIOR YEAR.

FIRST SEMESTER, 18 credit hours.

Mechanical Engineering 56	Steam Engine and Turbine Design I,	3
Mechanical Engineering 67	Thesis	1
Mechanics 55	Hydraulics	3
Mechanics 56	Hydraulic Laboratory	1
Engineering 51	Manufacturing	2
Electrical Engineering 1	Dynamo Machinery	3
Electrical Engineering 54	Electrical Laboratory	1½
Mechanical Engineering	Option (see below)	3
	Technical Report	½

SECOND SEMESTER, 16 credit hours.

Mechanical Engineering 66	Heat Engine Laboratory	1½
Mechanical Engineering 67	Thesis (continued)	2
Civil Engineering 50	Surveying	3
Engineering 52	Industrial Administration	3
Electrical Engineering 53	Alternating Currents	3
Electrical Engineering 55	Electrical Laboratory	1½
Mechanical Engineering	Option (see below)	3

Power Option.

FIRST SEMESTER.

Mechanical Engineering 58	Internal Combustion Motors I, or	3
Mechanics 58	Hydraulic Power	

SECOND SEMESTER.

Mechanical Engineering 57 Mechanical Engineering 59	Steam Engine and Turbine Design II, or Internal Combustion Motors II	3

Manufactures Option.

FIRST SEMESTER.

Mechanical Engineering 55	Refrigeration, or	3
Mechanical Engineering 61	Structural Design	

SECOND SEMESTER.

Mechanical Engineering 58	Internal Combustion Motors, or	3
Mechanical Engineering 62	Industrial Plant Design	

One extended inspection trip is required during the Junior or the Senior year.

MINING ENGINEERING.

SOPHOMORE YEAR.

FIRST SEMESTER, 19½ credit hours.

Course number.	*Subject.*	*Credit hrs.*
Mathematics 5 E	Calculus I	5
Geology I	Elementary Geology	5
Chemistry 2	Advanced Inorganic Chemistry	4
Civil Engineering 1	Surveying	3
Mechanical Engineering 1	Machine Drafting	1
Mach. Construction 6 (modified)	Bench and Lathe Work	1
	Technical Report I‡	½
	Mining Journal.	

SECOND SEMESTER, 17½ credit hours.

Mining Engineering 60	Mining Drawing	1
Physics 1 E	General Physics	5
Chemistry 3	Qualitative Analysis	4
Civil Engineering 1	Surveying (continued)	2
Mineralogy 10	Elementary Mineralogy I	5
	Technical Report II	½
	Mining Journal.	

SUMMER WORK.

Civil Engineering 3	Summer Field Work, 4 weeks.

JUNIOR YEAR.

FIRST SEMESTER, 18½ credit hours.

Mining Engineering 50	Mining	5
Mechanics 50	Mechanics	5
Geology 54	Economic Geology I	3
Chemistry 54	Quantitative Analysis I	5
	Technical Report III	½
	Mining Journal.	

SECOND SEMESTER, 17½ (or 18½) credit hours.

Mining Engineering 57	Mining Law (-)	1
Physics 2 E	General Physics	5
Mechanics 51	Strength of Materials	4
Mechanics 52	Testing Laboratory	1
Metallurgy 57	Assaying	5
Geology 55	Economic Geology II	2
	Technical Report IV	½
	Mining Journal.	

SUMMER WORK.

Mining Engineering 59	Summer Work.

SENIOR YEAR.

FIRST SEMESTER, 16 credit hours.

Mining Engineering 51	Ore Dressing	3
Mining Engineering 52	Power, Extraction, etc	5
Mining Engineering 58	Thesis	1
English 50 E	Advanced Composition	3
	Optional	4
	Mining Journal.	

SECOND SEMESTER, 17 (or 16) credit hours.

Mining Engineering 51	Ore Dressing (continued)	3
Mining Engineering 53	Sampling and Exploitation	3
Mining Engineering 57	Mining Law (-)	1
Mining Engineering 58	Thesis	2
Engineering 52	Industrial Administration	3
Metallurgy 62 E	Metallurgy II	3
Metallurgy 64 E	Iron and Steel	2
	Mining Journal.	

CHEMICAL ENGINEERING.

SOPHOMORE YEAR.

FIRST SEMESTER, 17½ credit hours.

Course number.	*Subject.*	*Credit hrs.*
Chemistry 2	Advanced Inorganic Chemistry	5
Mathematics 5 E	Calculus I	5
Physics 1 E	General Physics	5
Mechanical Engineering 1	Machine Drafting	1
Machine Construction 3	Forging	1
	Technical Report I	½

SECOND SEMESTER, 17½ credit hours.

Chemistry 3	Qualitative Analysis	5
Physics 2 E	General Physics	5
Mineralogy 10	Elementary Mineralogy I	5
Machine Construction 5	Bench Work	2
Machine Construction 6	Machine Tool Work I	
	Technical Report II	½

JUNIOR YEAR.

FIRST SEMESTER, 18½ credit hours.

Chemistry 4	Organic Chemistry I	5
Chemistry 54	Quantitative Analysis I	5
Mechanics 50	General Mechanics	5
English 50 E	Advanced Composition	3
	Technical Report III	½

SECOND SEMESTER, 19 credit hours.

Chemistry 51 A	Industrial Chemistry; Inorganic	3
Chemistry 55	Quantitative Analysis II	5
Chemistry 60	Organic Chemistry II	5
Mechanics 51	Strength of Materials	4
Mechanics 52	Testing Laboratory	1

SENIOR YEAR.

FIRST SEMESTER, 17½ credit hours.

Chemistry 51 B	Industrial Chemistry; Organic	3
Chemistry 64	Physical Chemistry I	5
Metallurgy 61 E	Metallurgy I	3
Metallurgy 65 E	General Metallurgy	2
	Optional from Chemistry Department, 4 hours or Optional 2 hours and Thesis 2 hours,	4
	Technical Report IV	½

SECOND SEMESTER, 17 credit hours.

Chemistry 65	Physical Chemistry II	5
Metallurgy 57	Assaying	3
Metallurgy 62	Metallurgy II	3
Engineering 52	Industrial Administration	3
	Thesis	3

One extended inspection trip is required during the Senior year.

ARCHITECTURAL ENGINEERING.

FRESHMAN YEAR.

FIRST SEMESTER, 17 credit hours.

Course number.	*Subject.*	*Credit hrs.*
Architectural Engineering 1	Free-hand Drawing I	2
Mathematics 2	College Algebra	3
Mathematics 3	Plane Trigonometry	2
German, French or Spanish*	(Course as approved.)	5
English 1 E	Rhetoric I	3
Engineering Drawing 1 and 2	Mechanical Drawing	2
Engineering 1	Engineering Lectures.	
Physical Education 1	Gymnasium, 3 periods per week.	

SECOND SEMESTER, 17 credit hours.

Architectural Engineering 2	Free-hand Drawing II	2
Mathematics 4 E	Analytic Geometry and Theory of Equations	5
German, French or Spanish	(Course as approved)	5
English 2 E	Rhetoric II	2
Engineering Drawing 3	Descriptive Geometry	3
Physical Education 2	Gymnasium, 3 periods per week.	

* French preferred.

SOPHOMORE YEAR.

FIRST SEMESTER, 18½ credit hours.

Architectural Engineering 3	Architectural Design I	3
Architectural Engineering 5	History of Architecture I	3
Architectural Engineering 7	Architectural Drawing I	1
Architectural Engineering 9	Shades and Shadows	1
Mathematics 5 E	Calculus I	5
Physics 1 E	General Physics	5
	Technical Report I	½

SECOND SEMESTER, 17½ credit hours.

Architectural Engineering 4	Architectural Design II	3
Architecturcl Engineering 6	History of Architecture II	3
Architectural Engineering 8	Architectural Drawing II	1
Physics 2 E	General Physics	5
Mathematics 6 E	Calculus II	3
Mechanical Engineering 4	Steam Machinery	2
	Technical Report II	½

JUNIOR YEAR.

FIRST SEMESTER, 18½ credit hours.

Architectural Engineering 50	Architectural Design III	3
Architectural Engineering 56	History of Architecture III	2
Architectural Engineering 58	Building Construction I	3
Chemistry 2	Advanced Inorganic Chemistry	4
Architectural Engineering 62	Architectural Drawing III	1
Mechanics 50	Mechanics	5
	Technical Report III	½

SECOND SEMESTER, 18½ credit hours.

Architectural Engineering 51	Architectural Design IV	3
Architectural Engineering 59	Building Construction II	3
Architectural Engineering 61	Building Sanitation	1
Architectural Engineering 63	Architectural Drawing IV	1
Mechanics 51	Strength of Materials	4
Mechanics 52	Testing Laboratory	1
Mechanics 53	Graphic Statics	3
Mechanical Engineering 54	Heating and Ventilation	2
	Technical Report IV	½

SENIOR YEAR.

FIRST SEMESTER, 18 credit hours.

Architectural Engineering 52	Architectural Design V	2
Civil Engineering 61	Stresses in Framed Structures	4
Civil Engineering 65	Reinforced Concrete	3
Economies 1 E	Elements of Economics	3
English 50 E	Advanced Composition	3
Electrical Engineering 64	Electrical Engineering for Architects,	3

SECOND SEMESTER, 15 credit hours.

Architectural Engineering 53	Architectural Design VI	2
Architectural Engineering 57	Thesis	3
Architectural Engineering 65	Steel Construction	3
Mechanics 57	Hydraulic Cement	1
Engineering 52	Industrial Administration	3
Civil Engineering 50	Surveying	3

ENGINEERING AND ADMINISTRATIVE SCIENCE.

SOPHOMORE YEAR.

FIRST SEMESTER.

(*a*) TRANSPORTATION GROUP. Same as in Civil Engineering.

(*b*) MANUFACTURING GROUP. Same as in Mechanical, Electrical, Mining, or Chemical Engineering.

SECOND SEMESTER.

(*a*) TRANSPORTATION GROUP. Civil Engineering schedule, modified by introduction of Elements of Economics.

(*b*) MANUFACTURING GROUP. Mechanical Engineering schedule, modified for those who have not taken Economics 1E.

JUNIOR AND SENIOR YEARS.

(*a*) TRANSPORTATION GROUP. To follow Civil Engineering schedule, with Economics 2E, Economic History of the United States; 3E, Elements of Accounting, and other approved courses substituted for engineering courses.

(*b*) MANUFACTURING GROUP. To follow Mechanical Engineering schedule, with the same substitutions of courses in Economics as those indicated above.

The total of courses in Economics, History and Sociology to be taken by students in Engineering and Administrative Science must amount to not less than 20 and not more than 26 hours.

CURRICULUM.

Leading to the Degree of Bachelor of Science.

REQUIREMENTS FOR ADMISSION.

To be admitted to these courses of study the student must have completed all of the requirements for admission and thirty hours of work in the College. His work should have been selected so that at the close of the year in the College he will have completed, in entrance work and in College work combined, the following specified units (a unit is understood to mean one complete College entrance unit or five credit hours in the University):

4 units in Mathematics.
4 units in English.
4 units in Foreign Language.
1 unit in Physics or Chemistry.

If his work has not been selected to fulfill these requirements, the student will be required to make up all deficiencies.

WORK REQUIRED FOR GRADUATION.

The various courses of study outlined below are designed to give approximately the same amount of technical work as is given in the regular four-year period, but the preceding year spent in College work enables the student to obtain a wider general education and to have a little greater freedom in the selection of some of his scientific and engineering studies.

In the selection of his work in foreign language, the student is required to complete not less than five units of foreign language, of which at least two and three-fifths units must be in one modern language.

CIVIL ENGINEERING.

(BASED ON ONE YEAR OF COLLEGE WORK.)

FRESHMAN YEAR.

FIRST SEMESTER, 16 credit hours.

Course number.	*Subject.*	*Credit hrs.*
Mathematics 4 E	Analytic Geometry	5
German, French or Spanish	(Course as approved)	5
Chemistry 2	Advanced Inorganic Chemistry	4
Engineering Drawing 1 and	Free-hand Drawing	2
Engineering Drawing 2	Mechanical Drawing	

SECOND SEMESTER, 17 credit hours.

Course number.	*Subject.*	*Credit hrs.*
Mathematics 5 E	Calculus I	5
German, French or Spanish	(Course as approved)	3
Chemistry 3	Qualitative Analysis	4
Engineering Drawing 3	Descriptive Geometry	3
Engineering Drawing 4	Machine Drawing	2

SOPHOMORE YEAR.

FIRST SEMESTER, 18½ credit hours.

Civil Engineering 1	Surveying	3
Mathematics 6 E	Calculus II	3
Physics 1 E	General Physics	5
Geology 1	Elementary Geology	5
Machine Construction 3 and Machine Construction 4	Forging and Machine Shop Practice	2
	Technical Report I‡	½

SECOND SEMESTER, 18 credit hours.

Civil Engineering 1 (continued)	Surveying	3
Civil Engineering 4	Railway Surveying	2
English 50 E	Advanced Composition	3
Physics 2 E	General Physics	5
Mechanical Engineering 5	Engines and Boilers	3
	Optional	2

SUMMER WORK.

Civil Engineering 3	Summer Field Work, 4 weeks.

JUNIOR YEAR.

FIRST SEMESTER, 17½ credit hours.

Civil Engineering 51	Cartography	2
Civil Engineering 55	Railway Surveying	4
Mechanics 50	Mechanics	5
	Optional	6
	Technical Report II‡	½

SECOND SEMESTER, 18½ credit hours.

Mechanics 53	Graphic Statistics	3
Civil Engineering 57	Railway Location	3
Mechanics 51	Strength of Materials	4
Mechanics 52	Testing Laboratory	1
Economics 1 E	Elements of Economics	3
Mechanics 56	Hudraulic Laboratory	1
Mechanics 55	Hydraulics	3
	Technical Report III‡	½

SUMMER WORK.

Civil Engineering 51	Summer Field Work, 4 weeks.

SENIOR YEAR.

FIRST SEMESTER, 17½ credit hours.

Civil Engineering 64	Masonry	2
Civil Engineering 65	Reinforced Concrete	3
Civil Engineering 61	Stresses in Framed Structures	5
Civil Engineering 70, or	Sanitary Engineering I	3
Electrical Engineering 60	Elements of Elec. Engineering	3
	Thesis‡	1
	Technical Report IV‡	½

SECOND SEMESTER, 16 credit hours.

Civil Engineering 62	Bridge Design	4
Engineering 52	Industrial Administration	3
Mechanics 57	Hydraulic Cement	1
Civil Engineering 75	Roads and Pavements	2
Civil Engineering 66	Reinforced Concrete Design	1
	Optional	3
	Thesis‡	2

One extended inspection trip is required during the Junior or the Senior year.

For Railway and Structural Engineering options, see page 15.

Municipal and Sanitary Option.

JUNIOR YEAR.

FIRST SEMESTER, 18½ credit hours.

Course number.	*Subject.*	*Credit hrs.*
Mechanics 50	Mechanics	5
Civil Engineering 73	Sanitary Science	2
Electrical Engineering 60	Elements of Elec. Engineering	3
Chemistry 56 E.	Water Analysis	5
Economics 1 E	Elements of Economics	3
	Technical Report II‡	½

SECOND SEMESTER, 16½ credit hours.

Civil Engineering 75	Roads and Pavements	2
Mechanics 57	Hydraulic Cement	1
Mechanics 55	Hydraulics	3
Mechanics 56	Hydraulic Laboratory	1
Civil Engineering 74	Waste and Garbage Disposal	1
Mechanics 51	Strength of Materials	4
Mechanics 52	Testing Laboratory	1
	Optional	3
	Technical Report III‡	½

SENIOR YEAR.

FIRST SEMESTER, 17½ credit hours.

Civil Engineering 64	Masonry	2
Civil Engineering 65	Reinforced Concrete	3
Civil Engineering 61	Stresses in Framed Structures	4
Civil Engineering 70	Sanitary Engineering I	3
	Thesis‡	1
	Optional	4
	Technical Report IV‡	½

SECOND SEMESTER, 18 credit hours.

Engineering 52	Industrial Administration	3
Civil Engineering 72	Sanitary Design	5
Civil Engineering 71	Sanitary Engineering II	4
Civil Engineering 52	City Planning	3
Civil Engineering 66	Reinforced Concrete Design	1
	Thesis‡	2

One extended inspection trip is required during the Junior or the Senior year.

ELECTRICAL ENGINEERING.

(BASED ON ONE YEAR OF COLLEGE WORK.)

FRESHMAN YEAR.

FIRST SEMESTER, 18 credit hours.

Course number.	*Subject.*	*Credit hrs.*
Mathematics 4 E	Analytic Geometry	5
Chemistry 2	Advanced Inorganic Chemistry	4
German, French, or Spanish	(Course as approved)	5
Engineering Drawing 1 and Engineering Drawing 2	Free-hand Drawing Mechanical Drawing	2
Machine Construction 1 and Machine Construction 2	Foundry Practice Pattern Making	2

SECOND SEMESTER, 17 credit hours.

Mathematics 5 E	Calculus I	5
Chemistry 3	Qualitative Analysis	4
German, French, or Spanish	(Course as approved)	3
Engineering Drawing 3	Descriptive Geometry	3
Engineering Drawing 4	Machine Drawing	2

SOPHOMORE YEAR.

FIRST SEMESTER, 18½ credit hours.

Physics 1 E	General Physics	5
Mathematics 6 E	Calculus II	3
Chemistry 64	Physical Chemistry I	5
Civil Engineering 50	Surveying	3
Mechanical Engineering 1	Machine Drafting	1
Machine Construction 3	Forging	1
	Technical Report I‡	½

SECOND SEMESTER, 17½ credit hours.

Mathematics	(Course to be elected)	3
Physics 2 E	General Physics	5
Mechanical Engineering 3	Elementary Machine Design	3
Mechanical Engineering 4	Steam Machinery	2
Economics 1 E	Elements of Economics	3
Machine Construction 5	Bench Work	1
	Technical Report II‡	½

JUNIOR YEAR.

FIRST SEMESTER, 17½ credit hours.

Electrical Engineering 50	Dynamo Machinery	3
Electrical Engineering 54	Electrical Laboratory	1½
Mechanics 50	Mechanics	5
Physics 52	Theory of Electricity	3
Physics 60 E	Electrical Measurements I	1½
Mechanical Engineering 52	Heat Engine Theory	3
	Technical Report III‡	½

SECOND SEMESTER, 18 credit hours.

Electrical Engineering 51	Theory of Alternating Currents	5
Electrical Engineering 55	Electrical Laboratory	1½
Mechanical Engineering 53	Mechanics of the Steam Engine	2
Mechanics 51	Strength of Materials	4
Mechanics 52	Testing Laboratory	1
English 50 E	Advanced Composition	3
Physics 61 E	Electrical Measurements II	1½

SENIOR YEAR.

FIRST SEMESTER, 16 credit hours.

Electrical Engineering 52	Advanced Dynamo Machinery	5
Electrical Engineering 56	Advanced Electrical Laboratory	1½
Mechanical Engineering 65	Power Laboratory	2
	Thesis‡	1
	Optional	6
	Technical Report IV‡	½

SECOND SEMESTER, 17 credit hours.

Electrical Engineering 57	Illuminating Engineering	3
Electrical Engineering 58	Electric Power Transmission	5
Engineering 52	Industrial Administration	3
	Optional	3
	Thesis‡	3

One extended inspection trip is required during the Junior or the Senior year.

MECHANICAL ENGINEERING.

FRESHMAN YEAR.

FIRST SEMESTER, 17 credit hours.

Course number.	*Subject.*	*Credit hrs.*
Mathematics 4 E	Analytic Geometry	5
Chemistry 2	Advanced Inorganic Chemistry	5
German, French, or Spanish	(Course as approved)	5
Engineering Drawing 1	Free-hand Drawing	1⅓
Engineering Drawing 2	Mechanical Drawing	⅔

SECOND SEMESTER, 17 credit hours.

Mathematics 5 E	Calculus I	5
Chemistry	(Optional)	5 or 3
	(College Optional)	3 or 5
Engineering Drawing 4	Machine Drawing	2
Machine Construction 1 and Machine Construction 2	Foundry Practice Pattern Making	2

SOPHOMORE YEAR.

FIRST SEMESTER, 17½ credit hours.

Mathematics 6 E	Calculus II	3
Physics 1 E	General Physics	5
Engineering Drawing 3	Descriptive Geometry	3
Machine Construction 3 and Machine Construction 5 and Machine Construction 6	Forging Bench Work Machine Tool Work I	3
Mechanical Engineering 2	Mechanism	3
	Technical Report I‡	½

SECOND SEMESTER, 17½ credit hours.

Physics 2 E	General Physics	5
Mechanical Engineering 6	Steam Engineering	4
Mechanics 50	Mechanics	5
	Optional	3
	Technical Report II‡	½

JUNIOR YEAR.

FIRST SEMESTER, 17½ credit hours.

Mechanics 51	Strength of Materials	4
Mechanics 52	Testing Laboratory	1
Mechanical Engineering 51	Thermodynamics	4
Mechanical Engineering 64	Mechanical Laboratory	1
Metallurgy 61 E	Metallurgy I	3
Economics 1 E	Elements of Economics	3
Machine Construction 7	Machine Tool Work II	1
	Technical Report III‡	½

SECOND SEMESTER, 17 credit hours.

Mechanical Engineering 50	Machine Design	4
Mechanical Engineering 54	Heating and Ventilation	2
Mechanical Engineering 60	Shop Methods	2
English 50 E	Advanced Composition	3
Mechanical Engineering 66	Heat Engine Laboratory	2
Machine Construction 8	Machine Shop Practice	1
	Optional	3

SUMMER WORK.

Mechanical Engineering 68	Summer Vacation Work.

SENIOR YEAR.

First Semester, 18 credit hours.

Mechanical Engineering 56	Steam Engine and Turbine Design I,	3
Mechanical Engineering 67	Thesis	1
Mechanics 55	Hydraulics	3
Mechanics 56	Hydraulic Laboratory	1
Engineering 51	Manufacturing	2
Electrical Engineering 50	Dynamo Machinery	3
Electrical Engineering 54	Electrical Laboratory	1½
Mechanical Engineering Option (see below)		3
	Technical Report	½

Second Semester, 17½ credit hours.

Mechanical Engineering 67	Thesis	2
Civil Engineering 50	Surveying	3
Engineering 52	Industrial Administration	3
Electrical Engineering 53	Alternating Currents	3
Electrical Engineering 55	Electrical Laboratory	1½
Mechanical Engineering Option (see below)		5

Power Option.

First Semester.

Mechanical Engineering 58	Internal Combustion Motors I, or	3
Mechanics 58	Hydraulic Power	

Second Semester.

Mechanical Engineering 57	Steam Engine and Turbine Design II	5
Mechanical Engineering 59	or Internal Combustion Motors II,	
	and Other Engineering Option	

Manufactures Option.

First Semester.

Mechanical Engineering 55	Refrigeration, or	3
Mechanical Engineering 61	Structural Design	

Second Semester.

Mechanical Engineering 58	Internal Combustion Motors, or	5
Mechanical Engineering 62	Industrial Plant Design, and	
	Other Engineering Option	

One extended inspection trip is required during the Junior or the Senior year.

MINING ENGINEERING.

FRESHMAN YEAR.

First Semester, 16 credit hours.

Course number.	*Subject.*	*Credit hrs.*
German, French or Spanish	(Course as approved)	5
Mathematics 4 E	Analytic Geometry and Theory of Equations	5
Engineering Drawing 1	Free-hand Drawing	1⅓
Engineering Drawing 2	Mechanical Drawing	⅔
Engineering Drawing 4 or	Machine Drawing	2
Machine Construction 3 and	Forging	
Machine Construction 4	Machine Work and Molding	
	Optional	2

Second Semester, 17 credit hours.

Mathematics 5 E	Calculus I	5
German, French or Spanish	(Course as app'd or other Optional),	3
Engineering Drawing 3	Descriptive Geometry	3
Geology 1	Elementary Geology	5
Engineering Drawing 4 or	Machine Drawing	1
Machine Construction 5	Bench Work	

SOPHOMORE YEAR.

FIRST SEMESTER, 18½ credit hours.

Mineralogy 10	Elementary Mineralogy I	5
Civil Engineering 1	Surveying	3
Physics 1 E	General Physics	5
Chemistry 2	Advanced Inorganic Chemistry	4
Mechanical Engineering 1	Machine Drafting	1
	Technical Report I‡	½
	Mining Journal.	

SECOND SEMESTER, 16½ credit hours.

Mining Engineering 60	Mining Drawing	1
Civil Engineering 1	Surveying	2
Physics 2 E	General Physics	5
Chemistry 3	Qualitative Analysis	4
Economics 1 E	Elements of Economics	3
Machine Construction 6	Machine Tool Work I	1

SUMMER WORK.

Civil Engineering 3	Summer Field Work, 4 weeks.

JUNIOR YEAR.

FIRST SEMESTER, 18½ credit hours.

Mining Engineering 50	Mining	5
Mechanics 50	Mechanics	5
Geology 52	Economic Geology I	3
Chemistry 54	Quantitative Analysis I	5
	Technical Report III‡	½
	Mining Journal.	

SECOND SEMESTER, 17½ (or 18½) credit hours.

Mining Engineering 57	Mining Law (-)	1
Mineralogy 62 E	Petrography	5
Metallurgy 57	Assaying	5
Geology 52	Economic Geology II	2
Mechanics 51	Strength of Materials	4
Mechanics 52	Testing Laboratory	1
	Technical Report IV‡	½
	Mining Journal.	

SUMMER WORK.

Mining Engineering 59	Summer Work.

SENIOR YEAR.

FIRST SEMESTER, 17 credit hours.

Mining Engineering 51	Ore Dressing	3
Mining Engineering 52	Power, Extraction, etc	5
Mining Engineering 58	Thesis	1
English 50 E	Advanced Composition	3
	Optional	5
	Mining Journal.	

SECOND SEMESTER, 16 (or 17) credit hours.

Mining Engineering 51	Ore Dressing (continued)	3
Mining Engineering 53	Sampling and Exploitation	3
Mining Engineering 57	Mining Law (-)	1
Engineering 52	Industrial Administration	3
Mining Engineering 58	Thesis	2
Metallurgy 62 E	Metallurgy II	3
Metallurgy 64 E	Iron and Steel	2

CHEMICAL ENGINEERING.

Note.—Students planning to take the four-year advanced course of study in chemical engineering are very strongly advised to elect chemistry 1 as part of their College work, in addition to the work already recommended in the statement preceding these advanced courses.

FRESHMAN YEAR.

First Semester, 17 credit hours.

Course number.	*Subject.*	*Credit hrs.*
Chemistry 2	Advanced Inorganic Chemistry	5
Mathematics 4 E	Analytic Geometry and Theory of Equations	5
Engineering Drawing 1 and	Free-hand Drawing	2
Engineering Drawing 2	Mechanical Drawing	
	Optional	5

Second Semester, 17 credit hours.

Chemistry 3	Qualitative Analysis	5
Mathematics 5 E	Calculus I	5
Engineering Drawing 3	Descriptive Geometry	3
Engineering Drawing 4	Machine Drawing	2
Machine Construction 1	Foundry Practice	2
Machine Construction 2	Pattern Making	

SOPHOMORE YEAR.

First Semester, 17½ credit hours.

Chemistry 54	Quantitative Analysis I	5
Physics 1 E	General Physics	5
Mechanics 50	Mechanics	5
Mach. Construction 3 (modified),	Forging	1
Mechanical Engineering 1	Machine Drafting	1
	Technical Report I‡	½

Second Semester, 18½ credit hours.

Chemistry 55	Quantitative Analysis II	5
Physics 2 E	General Physics	5
Mechanics 51	Strength of Materials	4
Mechanics 52	Testing Laboratory	1
Mechanical Engineering 3 or	Machine Design	3
Mechanical Engineering 5	Engines and Boilers	
	Technical Report II‡	½

JUNIOR YEAR.

First Semester, 18½ credit hours.

Chemistry 4	Organic Chemistry I	5
Metallurgy 61 E	Metallurgy I	3
Geology 1	Elementary Geology	5
English 50 E	Advanced Composition	3
Metallurgy 65 E	General Metallurgy	2
	Technical Report III†	½

Second Semester, 18½ credit hours.

Chemistry 60	Organic Chemistry II	5
Chemistry 51 A	Inorganic Industrial Chemistry	3
Metallurgy 62 E	Metallurgy II	3
Mineralogy 10	Elementary Mineralogy I	5
	Optional	2
	Technical Report IV‡	½

SENIOR YEAR.

FIRST SEMESTER, 17 credit hours.

Chemistry 51 B	Industrial Organic Chemistry	3
Chemistry 64	Physical Chemistry I	5
Chemistry	(Optional)	4
Economics 1 E	Elements of Economics	3
	Thesis‡	2

SECOND SEMESTER, 16 credit hours.

Chemistry 65	Physical Chemistry II	5
Metallurgy 57	Assaying	3
Engineering 52	Industrial Administration	3
	Optional	2
	Thesis‡	3

One extended inspection trip is required during the Senior year.

ARCHITECTURAL ENGINEERING.

FRESHMAN YEAR.

FIRST SEMESTER, 18 credit hours.

Course number.	*Subject.*	*Credit hrs.*
Architectural Engineering 1	Free-hand Drawing I	2
Mathematics 4 E	Analytic Geometry and Theory of Equations	5
German, French, or Spanish*	(Course as approved)	5
Chemistry 2	Advanced Inorganic Chemistry	4
Engineering Drawing 1 and 2	Mechanical Drawing	2

SECOND SEMESTER, 17 credit hours.

Architectural Engineering 2	Free-hand Drawing II	2
Mathematics 5 E	Calculus I	5
German, French, or Spanish	(Course as approved, or Optional)	3
Chemistry 3	Qualitative Analysis, or Optional	4
Engineering Drawing 3	Descriptive Geometry	3

SOPHOMORE YEAR.

FIRST SEMESTER, 18½ credit hours.

Architectural Engineering 3	Architectural Design I	3
Architectural Engineering 5	History of Architecture I	3
Architectural Engineering 7	Architectural Drawing I	1
Architectural Engineering 9	Shades and Shadows	1
Physics 1 E	General Physics	5
Mathematics 5 E	Calculus II	3
Machine Construction 1, and Machine Construction 2	Forging and Bench Work Woodworking and Molding	2
	Technical Report I‡	½

SECOND SEMESTER, 17½ credit hours.

Architectural Engineering 4	Architectural Design II	3
Architectural Engineering 6	History of Architecture II	3
Architectural Engineering 8	Architectural Drawing II	1
Physics 2 E	General Physics	5
Mechanical Engineering 4	Steam Machinery	2
	Optional	3
	Technical Report II‡	½

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* French preferred.

JUNIOR YEAR.

FIRST SEMESTER, 17½ credit hours.

Architectural Engineering 50	Architectural Design III	3
Architectural Engineering 56	History of Architecture III	2
Architectural Engineering 58	Building Construction I	3
Architectural Engineering 62	Architectural Drawing III	1
Mechanics 50	Mechanics	5
	Optional	3
	Technical Report III‡	½

SECOND SEMESTER, 18½ credit hours.

Architectural Engineering 51	Architectural Design IV	3
Architectural Engineering 59	Building Construction II	3
Architectural Engineering 61	Building Sanitation	1
Architectural Engineering 63	Architectural Drawing IV	1
Mechanics 51	Strength of Materials	4
Mechanics 52	Testing Laboratory	1
Mechanics 53	Graphic Statics	3
Mechanical Engineering 54	Heating and Ventilation	2
	Technical Report IV‡	½

SENIOR YEAR.

FIRST SEMESTER, 18 credit hours.

Architectural Engineering 52	Architectural Design V	2
Civil Engineering 61	Stresses in Framed Structures	4
Civil Engineering 65	Reinforced Concrete	3
Economics 1 E	Elements of Economics	3
English 50 E	Advanced Composition	3
Electrical Engineering 64	Electrical Eng. for Architects	3

SECOND SEMESTER, 15 credit hours.

Architectural Engineering 53	Architectural Design VI	2
Architectural Engineering 57	Thesis	3
Architectural Engineering 65	Steel Construction	3
Mechanics 57	Hydraulic Cement	1
Engineering 52	Industrial Administration	3
Civil Engineering 52	Surveying	3

EQUIPMENT.

The School of Engineering is a part of the University; hence the entire equipment of the University is also equipment of the School of Engineering in all things in which engineering students are concerned. The work of the Engineering School which is common to several schools of the University, such as mathematics, physics, chemistry, languages, etc., is carried on to some extent in buildings and by departments of instruction not exclusively for engineering students; while such work of the School as is technical and exclusively engineering in character is carried on by departments of instruction primarily for engineering students and largely in buildings erected for the special work of the School. Below is described that part of the general equipment of the University which pertains chiefly to the work of this School. For other equipment, see "The College" and descriptions of other schools of the University.

BUILDINGS.

The buildings erected exclusively for engineering work are Marvin Hall, the mechanical laboratory in connection with the power plant, and the Fowler Shops. The work in mining is provided for in Haworth Hall. For description of these buildings, see the General Information section.

LIBRARIES.

The general University library in Spooner Hall is available for use of engineering students. The engineering library in Marvin Hall contains books, periodicals, pamphlets, maps, and manuscripts for use in the study of civil, mechanical, electrical, and architectural engineering. The chemistry library contains books for the study of chemistry, metallurgy, and chemical engineering. The library in Haworth Hall contains books and maps for the study of geology, mineralogy and mining engineering. The books of physics and astronomy are in Blake Hall. The mathematics books are in the Liberal Arts Building. Large plates and other illustrative material for the use of architecture students are in the reading room of the architectural engineering department.

DRAWING ROOMS.

Drawing rooms in Marvin Hall, furnished with individual tables containing drawers for each student's outfit, cabinets for drawing boards, etc., are provided for the work in general mechanical drawing, machine design, bridge and structural design, and architecture. Drawing rooms in Haworth Hall are similarly provided for the work in mining engineering.

On the walls and in print cases are photographs and drawings of actual construction and blue prints of working drawings for bridges, railroad structures, sewers, waterworks, mine plants, buildings, etc.

LABORATORIES.

Instruction in science, both pure and applied, has come to depend very largely upon the laboratory. In the School of Engineering this has been realized, and care has been taken to provide the equipment which may be of maximum effectiveness in the teaching of undergraduates. In certain of the laboratories, moreover, the means are at hand for the carrying on of more advanced research work.

For the work in pure science the laboratories of the College departments of physics, chemistry and bacteriology are available. In this way engineering students are afforded all necessary opportunities for gaining familiarity with the most approved methods of carrying on work in the respective branches. Chemical-engineering students continue for a much longer time in the use of the apparatus provided in the department of chemistry than do the other students. Similarly, electrical-engineering students continue in the use of the finer types of electrical measuring instruments, which are provided in the well-equipped laboratories of the physics department. Mining-engineering students, and those following the civil-engineering option in sanitary and municipal work, draw largely also upon the pure-science laboratories, the former mainly in the lines of metallurgy and chemistry, the latter in the chemical and bacteriological examination of water and sewage.

In applied science the laboratories of the School of Engineering next come into use. Particular attention is given to the work which is given to large numbers of engineering students irrespective of department groups. Among these are: the laboratory for the investigation of the strength of materials, which is provided with a special machine on which loads may be carried to a maximum of 200,000 pounds, and in which several smaller-capacity machines are employed for all student work; the laboratory for experimental work in hydraulics, which is equipped for the usual work in the measurement of flow of water over weirs, through pipes, and for measuring performance of pumps, water motors, etc.; the complete outfit of surveying instruments, by means of which the department of civil engineering carries on its work in connection with the teaching of surveying in all of its various refinements; the laboratory for the study of electrical machines of all kinds, and which is especially well equipped with respect to standardizing apparatus for the most accurate forms of electrical measuring instruments employed in engineering practice; the laboratory devoted to the study of electric-lighting problems, equipped with modern photometer and other apparatus adequate for the work; the laboratory for the study of steam- and gas-engine power development, equipped with many representative types of engines, boilers, and other lines of equipment necessary for an actual study of operating conditions; and the machine-construction laboratory, which is equipped with machines for the carrying on of all of the ordinary processes in shop work, but which is so employed that students may be considered to be studying methods employed in the production of machines rather than engaged in acquiring manipulative skill.

A third form of laboratory equipment is that applied to special problems in connection with the various lines of specialized work. Each of the departments is equipped in this way, all in very satisfactory measure with respect to undergraduate student work. The civil-engineering department is equipped to give special work for those engaged in the advanced branches of railway surveying, and for the investigation of road-making materials. It owns a complete outfit for its work carried on during the summer surveying-camp period. The department of mechanics is equipped to carry on special investigations in reinforced concrete, and with various other forms of material employed in engineering structures. The electrical-engineering department is provided with necessary equipment for carrying on research work with alternating-current machinery, in telephony, and with electrical measuring instruments. The mechanical-engineering department, in connection with the University power plant, is able to carry on many lines of investigation in steam-power generation, with gas engines, with refrigerating apparatus, and in the study of fuels and lubricating oils. With the proper equipment, and in coöperation with the department of metallurgy, students are enabled to make special studies of tool steels, and the effects of heat upon metals of various kinds. The mining-engineering department is supplied with equipment necessary for the treating of all kinds of ore in accordance with the methods employed in actual practice, and also for experimental work in coal-washing and the general study of fuel. In the lines of applied chemistry the equipment is of high grade and well adapted to the carrying on of work characteristic of the chemical industry, as well as for the study of special metals and the analytical work on ores and the many other forms of material with which the industrial chemist must deal. In the rooms of the architectural-engineering department are deposited the many illustrative drawings, plates and lantern slides which are of service in the study of architectural forms and in creative designing work, which fills so important a position in the training of the architect.

DESCRIPTION OF COURSES.

The statement of "hours" refers to the number of hours per week in attendance at class. The value of each course is given in "credits," one credit being equivalent to one hour per week of recitation or lecture carried for a semester.

ARCHITECTURAL ENGINEERING.

Professor GOLDSMITH.
Professor GRIFFITH.
Professor H. A. RICE.
Mr. ———, Assistant Instructor.

1.—FREE-HAND DRAWING I. Charcoal and pencil drawing from the cast. Six hours, two credits, first semester, Monday, Wednesday, and Friday, at 8:30 to 10:30. Griffith.

2.—FREE-HAND DRAWING II. Theory of perspective, free-hand perspective, shades and shadows. Six hours, two credits, second semester. Griffith.

3.—ARCHITECTURAL DESIGN I. A study of the elementary architectural forms and fundamental construction features, their employment in architectural composition, the classic orders. Drafting-room work and informal lectures. Nine hours, three credits, first semester. Goldsmith and ———.

4.—ARCHITECTURAL DESIGN II. Continuation of course 3, the application of the orders in elementary design. A study and analysis of architectural composition based on the orders, designed to train the student in the æsthetics of architecture and the fundamentals of design. Drafting-room work and informal lectures. Nine hours, three credits, second semester. Goldsmith and ———.

5.—HISTORY OF ARCHITECTURE I. An analytical study of architectural development of the historic styles, explaining the underlying principles of construction and design, influence of materials, and effects of religious and political conditions. The first semester will include the architecture of Egypt, Assyria, Persia, Greece and Rome. Illustrated lectures, reading and sketching. Three hours, three credits, first semester, Monday, Wednesday, and Friday, at 9:30. Goldsmith.

6.—HISTORY OF ARCHITECTURE II. Continuation of course 5, from the close of Roman supremacy through the periods of Byzantine, Romanesque and Gothic development, and the Renaissance. Illustrated lectures, reading, sketching and research. Three hours, three credits, second semester, Monday, Wednesday, and Friday, at 10:30. Goldsmith.

7.—ARCHITECTURAL DRAWING I. Pencil drawing from casts of architectural ornament and historic details, designed to prepare the student for the free use of sketching in architectural composition and design. Three hours, one credit, first semester. Goldsmith.

8.—ARCHITECTURAL DRAWING II. Continuation of course 7. Pen, pencil, and brush work. Three hours, one credit, second semester. Goldsmith.

9.—SHADES AND SHADOWS. Application of the principles of descriptive geometry in casting conventional shadows. Conventional rendering of architectural subjects. Three hours, one credit, first semester. Goldsmith and ———.

50.—ARCHITECTURAL DESIGN III. Continuation of course 4. Problems in theoretical design alternating with problems in constructive design, working drawings and details, applying the knowledge gained in course 58. Nine hours, three credits, first semester. Goldsmith.

51.—ARCHITECTURAL DESIGN IV. Continuation of course 50. Problems in design of increased importance alternating with problems in constructive design based on course 59. Nine hours, three credits, second semester. Goldsmith.

52.—ARCHITECTURAL DESIGN V. A course of engineering design combining problems in engineering with architectural composition and applying the technical knowledge gained in the engineering courses. Six hours, two credits, first semester. Goldsmith.

53.—ARCHITECTURAL DESIGN VI. Continuation of course 52. Six hours, two credits, second semester. Goldsmith.

56.—HISTORY OF ARCHITECTURE III. Continuation of course 6, including the classic and Gothic revivals and modern architecture in Europe and the United States. Illustrated lectures, reading, sketching and research. Two hours, two credits, first semester. Goldsmith.

57.—THESIS. An extended problem in architectural-engineering design requiring complete plans, elevations, section and construction details, with outline specifications of building materials and methods. The subject may be chosen by the student with the approval of the professor of architecture. Six hours, two credits, second semester. Goldsmith.

58.—BUILDING CONSTRUCTION I. A study of the principles of wooden construction and their application in structural design, working drawings, and details. This course considers building and finishing woods, framing of wooden buildings, details of exterior finish, interior woodwork and cabinet work, hardware, glass, paints, and varnishes. Lectures, reading, and drafting-room work. Three hours, three credits, first semester. Goldsmith.

59.—BUILDING CONSTRUCTION II. A study of the principles of masonry construction and their application. This course considers building stones, brickwork, terra cotta, simple cast-iron and steel work, fireproofing and plastering. Lectures, reading, and drafting-room work. Three hours, three credits, second semester. Goldsmith.

61.—BUILDING SANITATION. Plumbing, sewerage, water-supply, and plumbing fixtures. Lectures, reading, and drafting-room work. One credit, second semester. Goldsmith.

62.—ARCHITECTURAL DRAWING III. Continuation of course 8. Three hours, one credit, first semester. Goldsmith.

63.—ARCHITECTURAL DRAWING IV. Continuation of course 62. Three hours, one credit, second semester. Goldsmith.

65.—STEEL CONSTRUCTION. A course in steel framing of buildings. Drafting-room work. Three credits, second semester. H. A. Rice.

BACTERIOLOGY.

Assistant Professor C. C. YOUNG.

53E.—SANITARY WATER ANALYSIS. (See chemistry 56E.) Open to students in engineering and to College Juniors and Seniors who have taken chemistry 3. Part of the semester will be devoted to bacteriological technic and reading along general lines, followed by special work on the bacteriology of water and sewage. The remainder of the semester will be spent in chemical quantitative analysis of water and sewage and interpretation of results of sanitary tests. Both semesters, 10 hours, daily, 8:30 to 10:30. Five credits. C. C. Young.

For other courses in bacteriology, see The College.

CHEMISTRY.

Professor E. H. S. BAILEY.
Professor CADY.
Professor DAINS.
Associate Professor WHITAKER.
Associate Professor ALLEN.
Assistant Professor C. C. YOUNG.
Assistant Professor BRUCKMILLER.
Assistant Professor FARAGHER.
Mr. RODEBUSH, Instructor.
Mr. WHELAN, Instructor.
Mr. LICHTENWALTER, Instructor.

2.—ADVANCED INORGANIC CHEMISTRY. Required of engineering students. For all but chemical-engineering students, lectures and recitations on Monday, Wednesday, and Friday, at 8:30; laboratory two hours, Tuesday or Thursday, 8:30 to 10:30, or 1:30 to 3:30; total of four credits. For chemical-engineering students, lectures and recitations on Monday, Wednesday, and Friday, at 8:30; laboratory four hours, Tuesday and Thursday, 8:30 to 10:30, or 1:30 to 3:30; total of five credits. First semester. Cady and assistants.

3.—QUALITATIVE ANALYSIS. For all but chemical-engineering students, recitations on Tuesday and Thursday, at 8:30; laboratory four hours, Monday and Wednesday or Wednesday and Friday, 8:30 to 10:30, or 1:30 to 3:30; total of four credits. For chemical-engineering students, recitations on Tuesday and Thursday, at 8:30; laboratory six hours, Monday, Wednesday, and Friday, 8:30 to 10:30 or 1:30 to 3:30; total of five credits. Second semester. Cady and assistants.

4.—ORGANIC CHEMISTRY I. Required of chemical-engineering students. Lectures, recitations, and laboratory work in aliphatic series. Must be preceded by courses 2 and 3. Junior, first semester, seven hours; lecture and recitations, Monday, Wednesday, and Friday, at 9:30; laboratory, Tuesday and Thursday, 1:30 to 3:30. Five credits. Dains.

5E.—ENGINEERING CHEMISTRY. Required of mechanical- and civil-engineering students. Second semester; recitations Tuesday and Thursday, at 9:30; laboratory Friday, 1:30 to 4:30. Three credits. Cady and assistants.

50E.—GAS ANALYSIS. A laboratory course in the quantitative determination of the common gases, analysis of gaseous mixtures, natural gas, flue gases, etc. Must be preceded by course 54. Optional, first semester, four hours, by appointment. Two credits. Allen.

51A.—INORGANIC INDUSTRIAL CHEMISTRY. Required of Junior chemical-engineering students. A study of the inorganic industries, including such topics as the manufacture of acids, alkalies and other chemicals, fertilizers, paints and pigments, glass and cement, and the purification of water. Prerequisites, courses 2 and 3. Three credits, second semester, at 11:30. Whitaker.

51B.—ORGANIC INDUSTRIAL CHEMISTRY. Required of Senior chemical-engineering students. A study of the organic industries, including such topics as the refining of petroleum, the distillation of wood and coal, packing houses, fermentation, soaps, leather, paper, starches, sugars, dyestuffs, etc. Prerequisites, courses 2, 3, 4. Three credits, first semester, at 9:30. Whitaker.

52E.—ELECTROLYTIC ESTIMATION OF METALS. A laboratory course. Must be preceded by course 54. Optional, second semester, four hours, by appointment. Two credits. Allen.

53E.—ANALYSIS OF BOILER FEED WATER. Must be preceded by course 54. Optional, first semester, four hours, by appointment. Two credits. C. C. Young.

54.—QUANTITATIVE ANALYSIS I. Lecture and laboratory work. Must be preceded by course 3. Required of chemical- and mining-engineering students. Both semesters. First semester, ten hours, 10:30 to 12:30 or 3:30 to 5:30; second semester, ten hours, 10:30 to 12:30. Five credits. Allen and assistants.

55.—QUANTITATIVE ANALYSIS II. Lecture and laboratory work. Required of chemical-engineering students. In the latter part of the course the volumetric analysis of ores and metallurgical products will be taken up. Second semester, ten hours, 1:30 to 3:30. Five credits. Allen and assistants.

56E.—SANITARY WATER ANALYSIS. (See bacteriology 53E.) Open to students in engineering and to College Juniors and Seniors who have taken chemistry 3. Part of the semester will be devoted to bacteriological technic and reading along general lines, followed by special work on the bacteriology of water and sewage. The remainder of the semester will be spent in chemical quantitative analysis of water and sewage and interpretation of results of sanitary tests. Both semesters, 10 hours, 8:30 to 10:30. Five credits. C. C. Young.

59.—WATER ANALYSIS. Laboratory work and conferences upon assigned readings. The course covers sanitary, mineral, and boiler-feed-water analysis, together with the principles and practice of the purification of water for municipal and other uses. Prerequisite, course 54. Three credits, second semester, by appointment. C. C. Young.

60.—ORGANIC CHEMISTRY II. A continuation of course 4. Lectures, recitations, and laboratory work, including the aromatic and other cyclic compounds. Must be preceded by course 4. Required of chemical-engineering students. Junior, second semester, seven hours, Monday, Wednesday, and Friday, at 9:30; laboratory, Tuesday and Thursday afternoons, by appointment. Five credits. Dains.

64.—PHYSICAL CHEMISTRY I. A course paying special attention to electrochemistry. Lectures and laboratory work. Must be preceded by course 54, or by course 3 and physics 1E and 2E and mathematics 5E. Required of chemical- and electrical-engineering students; optional for mining engineers. First semester, six hours, at 10:30. Five credits. Cady.

65.—PHYSICAL CHEMISTRY II. A general course in theoretical and physical chemistry. Lectures and laboratory work. Required of chemical-engineering students. Second semester, seven hours, at 10:30. Five credits. Cady.

Other courses in chemistry are open as optionals to chemical-engineering students. See The College.

CIVIL ENGINEERING.

Professor DALTON.*
Professor H. A. RICE, Chairman.
Professor WILLIAMS.
Associate Professor HASKINS.
Associate Professor MCNOWN.
Assistant Professor F. L. BROWN.
Assistant Professor ROBERTS.

1.—SURVEYING. Use, care and adjustment of surveying instruments. Methods involved in land, city, topographic and hydrographic surveying. Field practice in the use of tape, level and transit. Two hours of class work and one hour of field work, computation and plotting throughout the year are required of Sophomore civil-engineering students. Three credits for each semester. Two hours of class work throughout the year, and one hour of field work, computation and drawing for one semester are required of Sophomore mining-engineering students. Three credits the first semester and two the second. Tuesday and Thursday, at 10:30 and 11:30, with field work from 1:30 to 4:20 on the same days. Prerequisite, mathematics 3. McNown and Roberts.

3.—SUMMER FIELD WORK. A topographical survey is made of an area from a temporary camp as a base. Practice in taking topography by the transit and stadia, and plane table methods, measurement of a base line, triangulation, leveling, and determination of azimuth latitude and time with engineer's instruments, constitutes the work. Special attention is paid to camp organization and sanitation. Ten hours a day for four weeks at the close of the college year is required of Sophomore civil-engineering students, and the same for two weeks is required of Sophomore mining-engineering students. Prerequisite, civil engineering 1. McNown and F. L. Brown.

4.—RAILWAY SURVEYING. A study of railroad curves and earthwork, with field exercises. Second semester. Two credits. Prerequisite, civil engineering 1. Monday, Tuesday, Wednesday, and Friday, 9:30. Williams.

50.—SURVEYING. A briefer course than civil engineering 1, required of Senior mechanical, electrical and architectural students. Both semesters. Two hours of class work, Tuesday and Thursday, at 9:30 in the first and at 8:30 in the second semester. One hour of field work Friday afternoon. Three credits. McNown and Roberts.

51.—CARTOGRAPHY. Map projection and the preparation of an accurate topographical map based on the field maps prepared in civil engineering 3. Two hours per week in the first semester. Required of Junior civil-engineering students. Prerequisite, civil engineering 3. Tuesday and Thursday, 1:30 to 3:30. Two credits. McNown.

52.—CITY PLANNING. A study of city planning from the modern viewpoint, under such topics as city planning abroad, the American city, planning in advance and replanning, design of the street system, parks and playgrounds, civic centers, water features, methods of acquiring land, legislation. Lectures and assigned readings. Two credits. Required of Senior sanitary and architectural students, and optional Senior civil-engineering students. Second semester, Tuesday and Thursday, at 9:30. McNown.

53.—GEODESY. A brief study of the construction, use, and adjustment of the higher instruments of precision, and their use in the determination of the size and figure of the earth, including a study of the application of the method of least squares to the adjustment of observations. Two hours in class room and one by appointment in field and in computation. Optional to Seniors, first semester. Prerequisite, civil engineering 3. Three credits. McNown.

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* On leave of absence.

55.—RAILWAY SURVEYING. A study of the methods of laying out and constructing railways. The setting out of simple and compound curves and calculation of excavations and embankments. Yards, turnouts, and switches. Easement curves of various types. Calculation of waterways, and methods of staking out foundations for culverts and bridges. Monday, Tuesday, Wednesday, and Friday, at 9:30. Junior, first semester, with field practice consisting of a location survey of a line of sufficient length to familiarize the student with the method of doing such work. Prerequisite, civil engineering 1, 3 and 4. Four credits. Williams.

57.—RAILWAY LOCATION. The principles involved in economic location and construction of railways. Analysis of traffic and operating expenses. The influence of proposed changes in location upon the amount of total revenue from traffic, the bonded debt and the corresponding fixed charges for interest, the operating expense, and the dividend-paying capacity of the road. Junior, second semester, three hours, at 9:30 and 10:30. Prerequisite, civil engineering 55. Three credits. Williams.

58.—RAILWAY TERMINALS AND SIGNALING. A general study of the terminal problems, the design of yard layouts and of terminal structures. Some time given to signal engineering. Optional, Senior year, first semester. Prerequisite, civil engineering 55. Three credits. Williams.

59.—RAILWAY CONSTRUCTION AND MAINTENANCE. An advanced course in railway engineering. Optional for Seniors, second semester, three hours, Monday, Wednesday, and Friday, at 10:30. Three credits. Prerequisite, civil engineering 55. Williams.

61.—STRESSES IN FRAMED STRUCTURES. Analytical and graphical calculation of stresses in framed structures under various forms of loading. This course must be preceded by course 51 in mechanics. Senior, first semester, five hours, at 1:30. Five credits. H. A. Rice.

62.—BRIDGE DESIGNING. A study in bridge details and the dimensions of parts. Students work out designs for a plate girder and a simple truss. Must be preceded by course 61. Senior, second semester, eight hours, 1:30 to 4:30. Four credits. H. A. Rice.

64.—MASONRY. Character of materials composing masonry. Methods of cutting and dressing stone. Foundations: cribwork, cofferdams, caissons, piles and pile driving, concrete, pneumatic processes, etc. Senior, first semester, two hours, at 10:30. Two credits. Prerequisite, mechanics 51. Williams.

65.—REINFORCED CONCRETE. A course in the modern theory and practice in the design of beams, floor slabs, columns, conduits, retaining walls, arches, and other forms of reinforced concrete construction. Mathematical theory, study of plans, and design of typical structures. Senior, first semester, Monday, Wednesday, and Friday, at 10:30. Three credits. Prerequisite, mechanics 51. H. A. Rice.

66.—REINFORCED CONCRETE DESIGN. This course supplements course 65. Designs of beams, slabs, retaining walls, etc., together with a complete analysis of a reinforced-concrete arch, are made. Senior, second semester. One credit. Prerequisite, civil engineering 65. H. A. Rice.

67.—HIGHER STRUCTURES. An advanced course in bridges, including swing bridges, cantilever bridges, suspension bridges and arches. Some work will also be given in calculations of deflections and statically indeterminate stresses. Senior, second semester. Monday, Wednesday, and Friday, at 9:30. Three credits. H. A. Rice.

70.—SANITARY ENGINEERING I. An elementary course in the collection, removal and disposal of city sewage. Principles of the design and construction of sewers and storm drains. The collection and distribution of water supplies. Requisites of a supply as to quality and quantity. Design of distribution, collection, and storage works. Prerequisite, mechanics 55. First semester, three hours, Monday, Wednesday, and Friday, at 11:30. Three credits. Haskins.

71.—SANITARY ENGINEERING II. A more detailed study of the subjects treated in course 59. The purification of public water supplies and the treatment of sewage. Second semester, four hours, Monday, Tuesday, Wednesday, and Thursday, at 9:30. Four credits. Haskins.

72.—SANITARY ENGINEERING DESIGN. An advanced course to be taken simultaneously with course 71. The student works out, by practical problems, the principles learned in courses 70 and 71. Second semester, five hours, at 1:30. Five credits. Haskins.

73.—SANITARY SCIENCE AND PUBLIC HEALTH PROBLEMS. A broad general view of the large body of sanitary science upon which the modern practice of sanitation is based. The effects of good practice in such matters as public water supply, sewerage and drainage, state and federal control over the pollution of streams, vital statistics. First semester, two hours, Tuesday and Thursday, at 9:30. Two credits. Haskins.

74.—WASTE AND GARBAGE DISPOSAL. A lecture course in the practice of street cleaning, refuse and garbage collection and disposal. Second semester, one hour, Monday, at 11:30. One credit. Haskins.

75.—ROADS AND PAVEMENTS. A study of the materials for and the methods used in the construction and improvement of country roads and city pavements. Earthwork, drainage, and road foundation, the wearing surface, etc. The economic importance of the "good-roads movement." Junior, second semester, two hours, Tuesday and Thursday, at 11:30. Prerequisite, civil engineering 1, 3 and 4. Williams.

ECONOMICS.

Professor MILLIS.
Associate Professor BOYNTON.

1E.—ELEMENTS OF ECONOMICS. This course endeavors to explain the general laws of man's relation to wealth. Special attention is given to the parts of the subject of special interest to engineering students, such as corporations, the economic activities of municipalities, organized labor, and the general labor problem. First semester, three hours, Monday, Wednesday, and Friday, at 11:30. Millis.

2E.—ECONOMIC HISTORY OF THE UNITED STATES. Among the topics studied are: colonial agriculture, industry and trade; the effect upon American life of the westward expansion; the economic significance of slavery in the South and in the country at large; the industrial development of the North prior to the Civil War; the resources of the nation and the rise and importance of manufactures; banking, finance, transportation, and the tariff. A survey will be made of the present industrial situation under corporate methods, and of the outlook for democratic control of industrial conditions. Second semester, three hours, at 9:30. Boynton.

3E.—THE ELEMENTS OF ACCOUNTING. This course serves as an introduction to the field of accounting. The principles underlying various accounting practices are studied, and enough problems are solved to familiarize the student with the more common and simpler forms used in representing the progress and condition of a business firm. Prerequisite, course 1E or its equivalent. First semester, three hours, at 2:30. ———.

ELECTRICAL ENGINEERING.

Professor SHAAD.
Associate Professor C. A. JOHNSON.
Mr. SCHOOLEY, Instructor.

Courses 50 to 52, and 54 to 58, inclusive, and 61 are required of all electrical-engineering students. Courses 50, 53, 54, and 55 are required of mechanical-engineering students. Courses 59 and 62 are optional for electrical-engineering students.

50.—DYNAMO MACHINERY. Theory of direct-current generators and motors. Prerequisites, physics 1E and 2E. Junior, first semester, three hours, at 10:30 for electrical-engineering students, and at 8:30 for Senior mechanical-engineering students. Three credits. C. A. Johnson.

51.—THEORY OF ALTERNATING CURRENTS. A mathematical treatment of alternating-current phenomena and the theory of alternating-current machinery, fundamental types. Prerequisite, course 50. Junior, second semester, five hours, at 8:30, for electrical-engineering students. Five credits. Shaad.

52.—DYNAMO MACHINERY. Advanced theory of alternating-current machinery. Senior, first semester, five hours, at 8:30. Five credits. Shaad.

53.—THEORY OF ALTERNATING CURRENTS. A study of the theory of alternating currents and alternating-current machinery, together with a discussion of motor applications. Prerequisite, course 50. Senior, second semester, three hours, Monday, Wednesday, and Friday, at 11:30, for mechanical-engineering students. Three credits. Shaad.

54.—ELECTRICAL LABORATORY. An experimental course for the purpose of illustrating the principles of direct-current dynamo machinery and acquainting the student with the types and performance of direct-current apparatus. Must be preceded or accompanied by course 50. Junior, first semester, three hours, two days per week on alternate weeks, 1:30 to 3:30. One and one-half credits. C. A. Johnson and Schooley.

55.—ELECTRICAL LABORATORY. A continuation of course 54. Must be preceded or accompanied by course 51. More advanced work with direct-current machinery is given and experiments with alternating-current apparatus are introduced. Some time is devoted to the calibration of electrical instruments. Junior, second semester, three hours, two days per week on alternate weeks, 1:30 to 3:30. One and one-half credits. C. A. Johnson and Schooley.

56.—ELECTRICAL LABORATORY. Advanced experiments with electrical machinery and the testing of machines, chiefly of alternating-current types. Must be accompanied by course 52. Senior, first semester, three hours, two days per week, 1:30 to 4:30. One and one-half credits. Shaad and Schooley.

57.—ILLUMINATING ENGINEERING. A course in illumination and photometry, in which the available light sources are studied and the methods of application to artificial illumination of streets and buildings are discussed. Laboratory and field work in the measurement of light sources and illumination. Senior, second semester, three hours, Tuesday and Thursday, at 11:30. Three credits. C. A. Johnson.

58.—ELECTRIC POWER TRANSMISSION AND ELECTRIC RAILWAYS. A series of lectures and recitations devoted to the study of the principles involved and the methods used in the design of transmission and distributing systems and the theory and practice of the design, construction, and operation of electric railway systems. Prerequisite, course 52. Senior, second semester, five hours, at 9:30. Five credits. C. A. Johnson.

59.—Elementary Telephony. Lectures, recitations, and laboratory work. The principles that underlie all telephone apparatus, and practical experiments with the fundamental telephone transmitters, receivers, and central-station arrangements. Optional for Juniors or Seniors, second semester, five hours, by appointment. Five credits. Shaad.

60.—Elements of Electrical Engineering. A course covering the general field of electrical engineering, and prepared especially for civil-engineering students. Junior or Senior year, first semester, at 9:30. Three credits. Shaad.

61.—Professional Thesis. Senior, first semester, three hours, and second semester, nine hours, by appointment. Shaad, or other instructors, according to the line of work chosen.

62.—Central Stations. A study of the design, construction, operation, and management of central electrical stations and substations. Three hours in the classroom, Monday, Wednesday, and Friday, at 10:30, and one period in the drafting room each week. Three credits. Shaad.

63.—Advanced Electrical Laboratory. A continuation of course 56. More advanced and extended experiments with electrical machinery and circuits, introducing the experimental study of transient electrical phenomena. Seniors, second semester, by appointment. Five credits. C. A. Johnson.

64.—Electrical Engineering for Architects. A course covering electrical installation for buildings. For students in architectural engineering, either Junior or Senior year. First semester, three hours, at 9:30. Three credits. Shaad.

ENGINEERING.

Dean Walker.
Associate Professor Raymond.

1.—Engineering Lectures. A course of lectures given to Freshmen during the first semester. The purpose of the lectures is twofold: first, to give the student a more adequate idea of engineering as a profession and in its relation to the economic and industrial world; second, to enable those students who have not decided upon the courses of study to be pursued to gain a more definite conception of the field covered in each, and the requirements for success. About one-third of the course is given by the Dean and the remainder by different members of the engineering faculty. Tuesday, at 11:30.

51.—Manufacturing. Manufacturing processes employed in certain typical industries; elements of cost; power as a factor in costs; power applications; engineering practice in the industries with especial reference to selection of equipment. Senior, first semester. Tuesday and Thursday, at 8:30. Two credits. Walker.

52.—Industrial Administration. Development of modern industrial systems; forms of ownership—partnerships and corporations; contract principles, and practice in contract writing for engineering work; organization of transportation and manufacturing companies; elements of works management; analysis of costs; labor wage systems. Special lectures on real property, agency and torts. Senior, second semester, at 8:30. Three credits. Walker and law lecturers.

53.—The Literature of Engineering and Science. Reading and research in the material of the libraries, with indexing and reports. Optional for Seniors, either semester, by appointment. Three credits. Raymond.

ENGINEERING DRAWING.

Associate Professor HOOD.
Assistant Professor COCHRAN.
Assistant Professor ROBERTS.
Mr. HAZEN.

1.—FREE-HAND DRAWING. Engineering lettering in pencil and in ink. Free-hand working sketches of simple machine parts. Freshman, first twelve weeks of both semesters; Monday, Wednesday, and Friday, 8:30 to 10:30 or Monday and Wednesday, 8:30 to 11:30, Monday and Thursday, 1:30 to 4:30; Tuesday and Friday, 1:30 to 4:30, or Wednesday, 1:30 to 4:30, and Saturday, 8:30 to 11:30, six hours. One and one-third credits. Hood, Cochran, and Roberts.

2.—ELEMENTARY MECHANICAL DRAWING. Working drawings of simple machine parts. Penciling, tracing, and blue-printing. Detailing machine parts from assembly drawings. Freshman, last six weeks of both semesters, same hours as in course 1, six hours. Two-thirds credit. Hood, Cochran, and Roberts.

3.—DESCRIPTIVE GEOMETRY. Principles of projection. Execution of a large number of original exercises. Freshman, second semester, three hours, at 8:30, 9:30, 10:30, 11:30, or 3:30; also first semester, at 11:30. Three credits. Hood, Cochran, and Hazen.

4.—MACHINE DRAWING. Sketches of machine parts and preparation of working drawings; detailing of machines from sketches, notes, assembly drawings, and assembled machines; tracing and blue-printing; notes and lectures on drafting-room methods. Each student prepares complete drawings for some simple machine. Freshman, both semesters, same hours as in course 1, six hours. Two credits. Hood, Cochran, and Roberts.

ENGLISH LANGUAGE AND LITERATURE.

Assistant Professor RAYMOND.
Mr. MCCARTY, Instructor.
Miss LAIRD, Instructor.

The instruction in this department, while in essentials parallel to that in the College, is shaped with special reference to the other work of engineering students. The three courses here numbered are required before graduation; for students who wish to spend more time in work of this kind a research class is provided in the Graduate School, and appropriate classes in the College are open.

1E.—RHETORIC I. Written exercises and papers, with study of language usage. Required of all Freshmen. First semester, three hours, 8:30, 9:30, 10:30, 11:30, 2:30, 3:30. Three credits. Raymond, McCarty, and Laird.

2E.—RHETORIC II. Continuation of course 1. Second semester, two hours, 8:30, 9:30, 10:30, 11:30, 3:30. Two credits. Raymond, McCarty, and Laird.

50E.—ADVANCED COMPOSITION. Practice in the gathering and analyzing of material, and in the presentation of information and opinion in scientific papers, and study of the methods used in these and other papers. Required of all engineering students, one semester in Junior or Senior year, three hours; first semester, 10:30, 11:30; second semester, 8:30, 9:30. Three credits. Raymond.

For other work related to that of the English department see the courses in enginering, and under The College.

The department of English is provided with references, illustrative matter, and other helps for reading in general and in engineering literature, and in the preparation of special papers.

GEOLOGY.

Professor HAWORTH.
Associate Professor TWENHOFEL.
Assistant Professor TODD.

1.—ELEMENTARY GEOLOGY. A study of the elementary principles of geology, including a general outline of geologic principles and geologic agencies. An acquaintance with the elements of chemistry, zoölogy, and botany will be of advantage in this course. Required of Junior civil and Sophomore mining engineering students; first semester, 8:30, 9:30; second semester, 8:30, 9:30, 10:30, 11:30, 2:30. Five credits. Todd and Twenhofel.

54. ECONOMIC GEOLOGY I. A general study of the metallic and nonmetallic products of the mine and quarry, considered from a scientific and practical standpoint, including the nature, origin, amount, and geographic and geologic distribution of the same. Must be preceded by elementary chemistry and course 1, and mineralogy 10. Required of Junior mining-engineering students, first semester. Lectures and library work, three hours, Monday, Wednesday, and Friday, at 9:30. Three credits. Haworth.

55.—ECONOMIC GEOLOGY II. A continuation of course 54. Nonmetallic products. Second semester, two hours, Tuesday and Thursday, at 10:30. Two credits. Haworth.

Other courses in geology are open as optionals to engineering students. For details, see the courses listed under The College.

GERMAN.

Assistant Professor BRIGGS.
Mr. HAWKINS, Instructor.

1.—OUTLINE OF GRAMMAR. The first twenty-two lessons of the Otis-Carruth Grammar, with composition exercises; Carruth's Reader, about fifty pages. First semester, five hours, at 10:30. Five credits. Hawkins.

2.—GRAMMAR, READER, AND "TELL." The last eight lessons of Carruth's Grammar; Carruth's Reader completed. Schiller's Wilhelm Tell. First semester, five hours, at 1:30; second semester, five hours, at 10:30. Five credits. Hawkins.

3.—PROSE CLASSICS. Lessing's Minna von Barnhelm; extracts from Schiller's Der dreiszigjährige Krieg, preceded by a review of grammar. First semester, five hours, at 8:30; second semester, five hours, at 1:30. Five credits. Briggs.

4.—(Students wishing German 4 either semester will be accommodated in suitable sections in the College.) Five hours. Five credits.

6.—SCIENTIFIC PROSE. Lassar-Cohn's Die Chemie im täglichen Leben, Scientific Reader, and a general survey of German scientific literature. Intended to promote rapid, intelligent reading of scientific German. Either semester, three hours, at 9:30. Three credits. Briggs.

MACHINE CONSTRUCTION.

Assistant Professor F. E. WARD.*
Assistant Professor F. E. JONES.
Mr. WILTFONG, Instructor.
Mr. ROCKLUND, Instructor.
Mr. C. W. WHITE, Instructor.

The work given is designed to suit the needs of engineering students. It consists of practice work following demonstrations and recitations in the classroom. Textbook preparation and note writing are required in the class work. One hour of each regularly assigned weekly period is devoted to classroom work during a portion of the semester. In the advanced courses attention is given to modern machine-shop construction, the grouping of machines, and methods followed in standardizing production.

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* On leave of absence.

1.—FOUNDRY PRACTICE. Molding, and management of the cupola furnace and brass furnace. Practice in melting and pouring iron and nonferrous alloys. Each squad of students is required to have entire charge of the melting and casting of a heat of iron at least once during the course. Required of mechanical-, electrical- and chemical-engineering students. Three hours per week, both semesters. One credit. Rocklund.

2.—PATTERN MAKING. The principles of pattern making are studied in a practical way by having each student make patterns that are actually used in the foundry. Required of students in mechanical, electrical and chemical engineering. Three hours per week, both semesters. One credit. F. E. Jones.

3.—FORGING. Complete course, including stock calculations, bending, drawing, welding, tempering and hardening. Required of all excepting architectural students. Three hours per week, both semesters. One credit. Wiltfong.

4.—MACHINE SHOP AND PATTERN MAKING OR MOLDING. This is an abbreviated course arranged for students who do not take the regular courses 1, 2, and 5. The work includes a half semester of bench work in the machine shop, alternating with a half semester of either pattern making or molding. Required of students in civil and mining engineering. Three hours per week, second semester. One credit. White and F. E. Jones or Rocklund.

5.—BENCH WORK. A machine-shop course in the use and care of tools; practice in filing, chipping, drilling and riveting. Required of students in mechanical, electrical and chemical engineering. Three hours per week, first semester. One credit. White.

6.—MACHINE TOOL WORK I. Principally lathe work. Includes cutting off stock, centering, straight and taper turning and thread cutting; turning steel, wrought iron, cast iron and brass. Required of students in mechanical, electrical, chemical and mining engineering. Three hours per week, second semester. One credit. White.

7.—MACHINE TOOL WORK II. Use of planer, shaper, milling machine, boring mill, turret lathe; laying out and making machine parts from the drawing; gear cutting. Required of students in mechanical engineering. Three hours per week, second semester. One credit. White.

8.—ADVANCED MACHINE SHOP PRACTICE. Tool making. Hardening and tempering; grinding; autogeneous welding; jig making; preparing and using high-speed and alloy steels; assembling machinery. Required of students in mechanical engineering. Three hours per week, first semester. One credit. White.

MATHEMATICS.

Associate Professor ASHTON.
Assistant Professor JORDAN.
Mr. WHEELER, Instructor.
Doctor LEFSCHETZ, Instructor.
Mr. CONWELL, Instructor.

1.—SOLID GEOMETRY. The usual theorems and constructions of standard textbooks and applications to the mensuration of surfaces and solids. Second semester, two hours, at 1:30. Wheeler.

2.—COLLEGE ALGEBRA. Review of elementary algebra; graphic representation, logarithms, determinants. Required of all Freshmen in the School of Engineering; first semester, three hours, 8:30, 9:30, 10:30, 2:30, 3:30; second semester, three hours, 8:30. Three credits. Jordan, Wheeler, Lefschetz, and Conwell.

3.—PLANE TRIGONOMETRY. The six trigonometric functions, principal formulas of plane trigonometry, solution of triangles and practical problems. Required of all Freshmen in the School of Engineering. First semester, two hours, 8:30, 9:30, 10:30, 2:30, 3:30; second semester, two hours, 8:30. Two credits. Jordan, Wheeler, Lefschetz, and Conwell.

4E.—ANALYTIC GEOMETRY. Elementary theory of equations, Horner's method, the straight line and circle, conic sections, higher plane curves, solid analytic geometry. Required of all Freshmen in the School of Engineering. First semester, five hours, at 9:30; second semester, five hours, 8:30, 9:30, 10:30, 2:30. Five credits, Ashton, Jordan, Wheeler, and Lefschetz.

5E.—CALCULUS I. Differential calculus, applications to geometry and mechanics, maxima and minima, integral calculus, simple applications to length, areas, and volumes. Required of all Sophomores in the School of Engineering. First semester, five hours, 8:30, 10:30, 11:30; second semester, five hours, at 9:30. Five credits. Ashton, Jordan, Wheeler, and Lefschetz.

6E.—CALCULUS II. Applications of the calculus to problems of solid geometry, double and triple integration, applications to areas, volumes, centers of gravity, and moments of inertia; simple differential equations. Required of all Sophomores in the civil, electrical, and mechanical courses. First semester, three hours, at 11:30; second semester, three hours, 8:30, 9:30, 10:30. Three credits. Ashton, Jordan, and Lefschetz.

57E.—SELECTED TOPICS IN ENGINEERING MATHEMATICS. Complex numbers and vectors, exponential and trigonometric series, hyperbolic functions, differential equations of electrical and mechanical engineering, empirical curves, methods of approximation and numerical calculation. The course may be modified to suit the needs of the class. Optional for Juniors, Seniors, and graduates. Second semester, three hours, at 11:30. Jordan.

For other courses in mathematics, see The College.

MECHANICAL ENGINEERING.

Professor WALKER.
Associate Professor SIBLEY.
Associate Professor SLUSS.
Assistant Professor COCHRAN.
Assistant Professor GARVER.

1.—MACHINE DRAFTING. Making of working drawings from sketches of assembled parts, followed by an assembly drawing from detailed working drawings. Sophomore, first semester, Monday or Tuesday, 1:30 to 4:30, three hours. One credit. Garver.

2.—MECHANISM. A study of the motion of machine parts and of methods of transmission of motion by gears, belts, cams, and links. Recitations and drawing for mechanical-engineering students. Text, Sibley's Pure Mechanism. Sophomore, first semester, Tuesday and Thursday at 9:30 and Friday 1:30 to 4:30. Three credits. Garver.

3.—ELEMENTARY MACHINE DESIGN. Design of representative machine parts. Assembly of such parts and study of their relative motions. Sophomore, second semester, for electrical-engineering students. Monday and Wednesday at 9:30 and 1:30 to 4:30 on Tuesday. Three credits. Garver.

4.—STEAM MACHINERY. (*a*) Fuels, combustion, and steam generation. (*b*) A study of boiler and engine types. Principal text, Heat Engines, by Allen and Bursley. Required of electrical- and architectural-engineering students. Sophomore, second semester, two hours, Tuesday and Thursday, at 10:30. Two credits. Cochran.

5.—ENGINES AND BOILERS. A brief study of the general problem of steam power generation from the standpoint of the installing engineer. Text, Heat engines, by Allen and Bursley. Required of civil-engineering students. Sophomore, second semester. Monday, Wednesday, and Friday, at 9:30, and five exercises in the steam laboratory on Saturday, 8:30 to 12:30. Physics 1E is a prerequisite. Three credits. Garver.

6.—STEAM ENGINEERING. Elements of steam machinery, with special reference to combustion of fuels, boiler types, and engine mechanism, including the study of valve gears. Laboratory practice in proximate analysis of coal, and flue-gas analysis. Sophomore, second semester, for mechanical-engineering students. Chemistry 2 is a prerequisite. Monday, Wednesday, and Friday, at 8:30, and Wednesday or Thursday, 1:30 to 4:30. Four credits. Sluss.

50.—MACHINE DESIGN. Solution of problems in the design of general machine parts, including cylinders, plates, springs, riveted joints, bearings, journal shafts, gears, pulleys and belts. Lectures, recitations and drawing. Junior, second semester. Tuesday and Thursday, at 10:30, and Monday and Thursday, 1:30 to 4:30. Four credits. Garver.

51.—THERMODYNAMICS. The relations between heat and mechanical energy, theory of heat engines. Must be preceded by physics 1E and calculus. Required of mechanical-engineering students. Junior, first semester, Monday, Wednesday, and Friday, at 8:30. Three credits. Walker.

52.—HEAT-ENGINE THEORY. A course for electrical-engineering students, treating the science of thermodynamics more briefly than in the preceding course and including engine applications. Junior, first semester. Monday, Wednesday, and Friday, 9:30. Three credits. Garver.

53.—MECHANICS OF THE STEAM ENGINE. Study of the action of slide valves with fixed and movable eccentric and of Corliss valves, governors, the force and inertia problem, and shaking forces. Required of electrical-engineering students. Course 52 is a prerequisite. Junior, second semester, two hours, Tuesday and Thursday, at 9:30. Two credits. Sluss.

54.—HEATING AND VENTILATION. Laws of heat transfer, amount of air required for ventilation, methods and apparatus employed in modern buildings, central heating plants. Junior, second semester, two hours, at 11:30. Two credits. Sibley.

55.—REFRIGERATION. Principles of mechanical refrigeration. Ice-manufacturing and cold-storage plants from the standpoint of American practice. Recitation, designing-room work, and laboratory exercises with ammonia machine. Optional, first semester, Monday, Wednesday, and Friday, at 9:30. Three credits. Sluss.

56.—STEAM-ENGINE AND TURBINE DESIGN I. Includes a brief review of the thermodynamics of engines and turbines. Determination of sizes for given horsepower; methods of compounding, regulation and balancing; study of details, including valves and valve gears, cylinders, rotating and reciprocating parts of engines, and nozzles, blades, and rotors of turbines. Required of mechanical-engineering students. Two hours recitation and three hours drawing per week, first semester. Three credits. Sibley.

57.—STEAM-ENGINE AND TURBINE DESIGN II. Application of principles covered in course I to the design of special types. Optional for mechanical-engineering students. Second semester. Three credits. Sibley.

58.—INTERNAL-COMBUSTION MOTORS I. General theory and practice of gas-engine design and construction. Senior, first semester, Monday and Tuesday, at 1:30, Wednesday and Thursday of alternate weeks, 1:30 to 4:30. Three credits. Sibley.

59.—INTERNAL-COMBUSTION MOTORS II. Application of principles covered in course I to the design of special types of gas engines. Senior optional, second semester, by appointment. Three credits. Sibley.

60.—SHOP METHODS AND EQUIPMENT. A study of the design, construction and operation of the modern machine shop. Small tools and equipment; machine tools and shop layouts; the routing and tracing of work; theory of time studies and instruction-card writing; cost accounting. One hour recitation and three hours laboratory per week, second semester. Friday, at 10:30. One and one-half credits. Sibley and Garver.

61.—STRUCTURAL DESIGN. Stresses in steel and reinforced concrete buildings, and design of members of the structure. Optional for Seniors. First semester, Monday, Wednesday, and Friday, at 11:30. Sibley.

62.—INDUSTRIAL-PLANT DESIGN. Planning of manufacturing plants; location, transportation; routing of work; handling material. Senior optional, second semester, designing room three hours by appointment. Three credits. Sibley.

64.—MECHANICAL LABORATORY. Calibration of thermometer and indicator springs, physical properties of lubricating oils, valve setting, commercial testing of boilers, engines and pumps. For mechanical-engineering students, first semester, Junior, Wednesday or Thursday, 1:30 to 4:30. One credit. Sluss and Garver.

65.—POWER LABORATORY. Calibration of apparatus, fuel testing, laboratory tests of steam and gas prime movers, complete power-plant test. Outside preparation of preliminary and final reports. Prerequisites, mechanical engineering 4, 52 and 53. For electrical-engineering students. Senior, first semester, Monday or Tuesday, 1:30 to 4:30. One and one-half credits. Sluss.

66.—HEAT-ENGINE LABORATORY. Study of experimental engineering methods and their application to complete tests of boilers, steam and gas prime movers, compressors, and refrigerating units. Drill in report writing, and outside reading of literature bearing on power development. Prerequisites, mechanical engineering 6, 51 and 56. For mechanical-engineering students. Senior, second semester, Monday or Tuesday, 1:30 to 4:30. One and one-half credits. Sluss.

67.—THESIS. Senior, both semesters, Friday, 1:30 to 4:30. Three credits. Sibley and Sluss.

68.—SUMMER VACATION WORK. Two months to be spent in regular work in some shop or manufacturing plant of good standing. A report on this work, with a certified statement from the shop foreman or the superintendent, must be presented before credit can be given.

MECHANICS.

Professor H. A. RICE.
Assistant Professor BROWN.
Assistant Professor ROBERTS.
Mr. SEVERNS.

50.—MECHANICS. A study of the laws of statics and dynamics. Action of forces upon bodies, and the resulting motions. Required of all engineering students. Junior, first semester, five hours, at 9:30, 10:30, 11:30; second semester, 10:30. Five credits. Prerequisite, calculus I. H. A. Rice and Brown.

51.—STRENGTH OF MATERIALS. The theory of resistance to stress and application to engineering construction. Required of all engineering students. Junior, first semester, four hours, 8:30; second semester, 8:30, 9:30, 10:30. Prerequisite, mechanics 50. Four credits. H. A. Rice and Brown.

52.—TESTING OF MATERIALS. A laboratory course to accompany course 51. The testing of iron, steel, wood, and other materials of construction for resistance to tension, compression, torsion, bending, and shearing. Experimental determination of the limits of safe loading. The testing of paving brick. Junior, second semester, four hours, Monday, Wednesday, Thursday, or Friday afternoon, or Staturday morning. One credit. Brown and Severns.

53.—GRAPHIC STATICS. The properties of equilibrium polygons and other methods of representing the actions of forces, with application to the determination of stresses in beams, roof trusses, and stone arches. Lectures and drawing. Junior, second semester, nine hours, 1:30 to 4:30. Two credits. Prerequisite, mechanics 50. Brown.

54.—ENGINEERING MATERIALS. A study of the methods of manufacture of structural materials and the different means and machines used in their testing. Opportunity will be given for specialization along some particular line, if desired, and considerable experimental work may be done in the laboratory. Recitations, lectures, library, and laboratory work. Optional for Seniors, first semester, —— hours, by appointment. Two or five credits. Prerequisite, mechanics 51. H. A. Rice.

55.—HYDRAULICS. A study of the laws governing the pressure and flow of liquids. Calculation of the flow through pipes and over weirs. The principles and types of pumping and hydraulic power machinery. Required of Junor civil and Senior mechanical-engineering students. First semester, 9:30, and second semester three hours, 9:30, 10:30. Three credits. Prerequisite, mechanics 50. Roberts.

56.—HYDRAULIC LABORATORY. A course to accompany course 55. Experimental work with the flow of water over weirs and through orifices and pipes, and in testing hydraulic machinery. Required of Junior civil and Senior mechanical-engineering students. First and second semesters, two hours, Monday, Wednesday, or Friday, 3:30 to 5:30. One credit. Severns.

57.—HYDRAULIC CEMENT. A laboratory course in testing hydraulic cements and making comparison of their qualities. Reading, experimental work, and reports of tests made. For Senior civil-engineering students, second semester, two hours, Monday or Thursday, 3:30 to 5:30. One credit. Prerequisite, civil engineering 64. Williams.

58.—HYDRAULIC POWER. Waterpower development. Rainfall and runoff, stream flow, preliminary plant layout, selection of standard water turbines, turbine design. Senior optional, first semester, by appointment. Three credits. ———.

METALLURGY.

Associate Professor WHITAKER.
Mr. PARKHURST.

57.—ASSAYING AND METALLURGICAL ANALYSIS. The first half of the semester is devoted to the fire assay of gold, silver, and other metals; the second half to the volumetric assay of ores and furnace products. Junior mining-engineering students are required to take the entire course, carrying five credits; the Senior chemical-engineering students are required to take fire assaying the first half of the semester, and will receive three credits. Second semester, five or ten hours, Tuesday and Thursday, 1:30 to 3:30. Three or five credits. Whitaker and Parkhurst.

61E.—METALLURGY I. General metallurgy and the metallurgy of iron and steel. Lectures and recitations. Must be preceded by chemistry 3. Required of Junior mechanical-engineering students and Senior chemical-engineering students. First semester, three hours, at 11:30. Three credits. Whitaker.

62E.—METALLURGY II. Metallurgy of lead, zinc, and copper, followed by that of silver, gold, mercury, and tin. Required of Senior mining- and chemical-engineering students. Second semester, three hours, Monday, Wednesday, and Friday, at 9:30. Prerequisite, chemistry 3. Three credits. Whitaker.

63.—METALLURGICAL LABORATORY. Pyrometric and calorimetric measurements, preparation of silicates and alloys, oxidation and reduction reactions, amalgamation, chlorination, cyaniding and leaching, etc. Optional for Juniors, Seniors, and graduate students who have taken or are taking course 61E or course 62E. Either semester, two hours, by appointment. Whitaker.

64E.—IRON AND STEEL. A repetition in briefer form of course 61E. Required of Senior mining-engineering students, second semester, two hours, Tuesday and Thursday, at 9:30. Two credits. Parkhurst.

65E.—GENERAL METALLURGY. Physical properties of metals and alloys, thermal analysis, the measurement of high temperatures, refractories, slags, matte bullion, typical metallurgical operations. Required of chemical engineers, first semester, Tuesday and Thursday, at 11:30. Two credits. Whitaker.

MINERALOGY.

Professor HAWORTH.
Assistant Professor TODD.

10.—ELEMENTARY MINERALOGY I. A brief course in crystallography, blowpipe analysis, and systematic mineralogy, consisting of lectures and laboratory work. Sophomore, second semester, ten hours, 3:30 to 5:30. Five credits. Todd.

61.—PETROGRAPHY. This course includes a study of the mineralogical and chemical composition of rocks, their origin, structural features, and classification. First semester. Five credits. Haworth.

Other courses in mineralogy are open to engineering students as optionals. For these, see The College.

MINING ENGINEERING.

Professor HAWORTH.
Professor HUMBLE.
Associate Professor C. M. YOUNG.*
Associate Professor DICKINSON.
Mr. BELCHIC.

50.—MINING. Underground surveying, to be supplemented by field work. Excavation for mining purposes, quarrying, boring for gas, oil, and water. Manufacture and use of explosives. Sinking of shafts, tunneling, support of underground excavations. Lectures and recitations. Junior, first semester, five hours, at 11:30. Five credits. Dickinson.

51.—ORE DRESSING. Methods used for the separation and concentration of valuable minerals. Recitations, lectures, and laboratory work. Richard's Text Book of Ore Dressing. Senior, first semester, three hours, at 11:30, three credits; second semester, three hours, at 10:30, three credits. Dickinson and Belchic.

52.—POWER, EXTRACTION, DRAINAGE, VENTILATION. Steam, compressed air, and electricity as applied to mining; mining hydraulics and the drainage of mines; handling of ore underground and on the surface; ventilation; mine accidents. Includes a visit to the lead-zinc district of Kansas and Missouri and a report. Senior, first semester, five hours, at 9:30. Five credits. Dickinson.

53.—SAMPLING AND EXPLOITATION. Methods of sampling, developing, and working mineral deposits, including studies of important mining districts. Senior, second semester, five hours, at 11:30. Three credits. Dickinson.

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* On leave of absence.

54.—MINE PLANT. Equipment necessary for the exploitation of mineral deposits and of important examples; building materials, foundations, mine buildings; the design of mine plants. Optional for students of mining engineering. Senior, second semester, five hours, at 9:30. Five credits. Dickinson.

55.—MINE ADMINISTRATION. Mine accounts and management, care of sick and injured in case of accident, rules and regulations for equipping expeditions and maintaining camps. Optional for mining-engineering students. Senior, first semester, five hours, by appointment. Two and one-half credits. Dickinson.

56.—COAL MINING. Methods of working coal beds and of handling coal. Properties of mine gases, safety lamps, explosives, ventilation, cause and prevention of explosives. May be substituted for course 52. Open to students not enrolled in the course in mining engineering. Second semester, five hours, at 9:30. Five credits. ———.

57.—MINING LAW. Outline of the laws relating to the mining industries. Recitations and lectures. Second semester, one hour, in alternate years. Humble.

58.—PROFESSIONAL THESIS. This may be an elaborate description of a mining or metallurgical plant or of a mining district, or may be founded upon research work done at the University. By appointment. Three credits. Haworth.

59.—SUMMER WORK. Each candidate for a degree is required to give evidence of having had experience in some phase of mining work. This may be gained by an investigation of some mining district under the direction of an instructor for a period of six weeks, or by employment in mining work.

60.—MINING DRAWING. Drawing and coloring mine maps and mine sections, use of symbols to show nature and geological structure, coal-mine maps, use of the plane table for topographic surveying. Sophomore, second semester, Monday, 1:30 to 3:30, three hours. One credit. Dickinson.

PHYSICAL EDUCATION.

Professor NAISMITH.
Associate Professor HAMILTON.
Assistant Professor HARGISS.
Mr. LORENZ.

FRESHMAN 1. First half-semester, soccer, football, elementary gymnastics, and track work; second half-semester, basketball, tumbling, apparatus work, swimming.

FRESHMAN 2. First half-semester, apparatus work, swimming, diving, etc.; second half-semester, track athletics, high jump, etc., or lacrosse.

Freshman are required to attend classes three periods per week. Special classes are organized for engineers at such times as the majority can attend.

Additional courses will be arranged for special work and the prescribed work which can not be done in class.

Every student may receive a thorough medical and physical examination, with the results platted on a chart. When needed special exercises will be prescribed.

Every student using the gymnasium, or who is a candidate for any University team, must pass a satisfactory medical and physical examination.

PHYSICS.

Professor KESTER.
Associate Professor M. E. RICE.
Assistant Professor STIMPSON.
Assistant Professor T. T. SMITH.
Assistant Professor CORNELIUS.

1E.—GENERAL PHYSICS. A fundamental course of experimental lectures, recitations, and problems. Prerequisites, plane trigonometry and some knowledge of analytical geometry and calculus. Sophomore, first semester; lectures and recitations on Tuesday, Wednesday, Thursday, and Friday, at 11:30; laboratory two hours, Monday, at 8:30 to 10:30, or Monday, Wednesday, or Friday, 1:30 to 3:30. Given also in the second semester; lectures and recitations on Monday, Tuesday, Thursday, and Friday, at 10:30, laboratory two hours, Wednesday, at 10:30 to 12:30, or Friday, 1:30 to 3:30. Five credits. First semester, M. E. Rice and other instructors; second semester, T. T. Smith and other instructors.

2E.—GENERAL PHYSICS. A continuation of course 1E. Sophomore, second semester, lectures and recitations on Tuesday, Wednesday, Thursday, and Friday, at 11:30, laboratory two hours, Monday, 8:30 to 10:30, or Monday, or Wednesday, 1:30 to 3:30. Given also in the first semester; lectures and recitations on Monday, Tuesday, Thursday, and Friday, at 10:30; laboratory two hours, Friday, 1:30 to 3:30. Five credits. Second semester, M. E. Rice and other instructors; first semester, T. T. Smith and other instructors.

52.—THEORY OF ELECTRICITY AND MAGNETISM. Junior, first semester, three hours, at 11:30. Three credits. M. E. Rice.

60E.—ELECTRICAL MEASUREMENTS I. A laboratory course coördinate with 52. First semester, three hours per week, Monday and Tuesday of alternate weeks, 1:30 to 3:30. One and one-half credits. M. E. Rice.

61E.—ELECTRICAL MEASUREMENTS II. Continuation of course 60E. Second semester, three hours, Monday and Tuesday of alternate weeks, at 1:30 to 3:30. One and one-half credits. M. E. Rice.

For other courses in physics, see The College and The Graduate School.

ROMANCE LANGUAGES.

Professor GALLOO.
Assistant Professor WINTER.
Miss GARDNER, Instructor.

FRENCH.

1.—ELEMENTARY FRENCH I. Grammar (Fraser and Squair), and easy reading. Drill in pronunciation, accidence, and easy syntax. First semester, five hours, at 10:30. Five credits. Miss Gardner.

2.—ELEMENTARY FRENCH II. A continuation of course 1. Reading of simple prose texts, with exercises in dictation and elementary composition. Second semester, five hours, at 10:30. Five credits. Miss Gardner.

(Instead of taking course 3, engineering students should take course 5. Those wishing course 4 may take it either semester in the College.)

5.—SCIENTIFIC FRENCH. Translation of some scientific text. Reading and reports of current French scientific and technical periodicals. The aim of this course is to give the students a reading knowledge of the French language of science for practical use in research work. First semester, three hours, at 11:30. Three credits. Prerequisites, courses 1 and 2. Miss Gardner.

SPANISH.

1.—ELEMENTARY SPANISH I. An outline of grammar (Olmsted and Gordon). Reading of short stories. Elementary composition. First semester, five hours, at 8:30, 9:30, 1:30; also second semester, five hours, at 1:30. Five credits. Winter, and Miss Gardner.

2.—ELEMENTARY SPANISH II. Grammar and composition. Reading of easy modern prose. Carrión-Aza, Pérez Galdós, Ibáñez, etc. Second semester, five hours, at 9:30, or 1:30. Five credits. Winter and Miss Gardner.

For advanced courses in Spanish, see The College.

TECHNICAL REPORTS AND THESES.

Special written reports are required from each student at certain times during his course of study, generally one in each semester of the Sophomore year, one in the Junior year, and one in the Senior year. A student enrolled for technical report I, II, III, or IV confers with his instructor for assignment of the subject on or before October 15 for the first semester, and on or before March 15 for the second semester. The finished reports must be in the instructors' hands by January 15 and May 15 of the respective semesters. Each report counts for one-half credit.

A special thesis is required of each student before his graduation. (See "Thesis" in the description of courses of the professional departments.)

Standard forms for the make-up of technical reports, theses, and other written papers are specified in an official circular to be had at the Dean's office.

SUMMER WORK.

In the several courses of study practical work in one or two summers is required. This work is not measured in terms of credit hours, although in fixing the requirements for graduation one or two additional credit hours are required in those courses of study which do not include summer work.

INSPECTION TRIPS.

As a valuable adjunct to resident study at the University, inspection trips to various engineering works are required to be taken by students with their instructors. Such trips may be made to large machine shops, power plants, steam or electric railways, lighting systems, city waterworks, sewerage systems, industrial chemical plants, cement works, mining plants, or smelters. Architectural-engineering students are expected to visit important buildings in course of construction. These trips may be made during regular sessions of the school or during vacation. Parties sometimes travel as far as Chicago or St. Louis. The trips requiring absence from other work and those of considerable expense are indicated in the programs of required courses of study.

ENGINEERING EXPERIMENT STATION.

STATION STAFF.

Frank Strong, Ph. D., President.
P. F. Walker, M. M. E., Director. Mechanical Engineering.
E. Haworth, Ph. D., Mining Engineering.
George C. Shaad, E. E., Electrical Engineering.
Herbert A. Rice, C. E., Mechanics and Civil Engineering.
Goldwin Goldsmith, Ph. B., Architectural Engineering.
W. A. Whitaker, A. M., Chemical Engineering.

PURPOSES.

This department of University activity has been established for two reasons: first, to correlate and group together in a more systematic way the results of scientific investigation that heretofore has been done under the various departments; second, to foster, enlarge, and direct this work, especially along lines of value to this state, and to supervise the publication and distribution of the results of engineering and industrial research work.

The work completed and published up to the present time has been done mainly by members of the teaching staff. It is described in detail in section XII, "Special Activities," of the complete catalog. Lists of all publications and of those soon to be issued are given. All communications relative to the Station and its work should be addressed to the Director.

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1915/16

THE
UNIVERSITY OF KANSAS

ANNUAL CATALOG

1915-1916

SECTION IV
SCHOOL OF ENGINEERING

UNIVERSITY OF ILLINOIS
AUG 31 1917
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Bulletin of University of Kansas, Vol. 17, No. 4, March 1, 1916

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ANNUAL CATALOG OF THE UNIVERSITY OF KANSAS,

Embracing the following separate sections:

- I. General Information.
- II. Graduate School.
- III. College of Liberal Arts and Sciences.
- IV. Engineering School.
- V. School of Fine Arts.
- VI. School of Law.
- VII. School of Pharmacy.
- VIII. School of Medicine.
- IX. School of Education.
- X. Summer Session.
- XI. Extension Division.
- XII. The Divisions of Athletics, Libraries, Museums, Publications, State Service Work, University Surveys.
- XIII. Register of Degrees conferred and students in residence during the year.

Any of these publications will be sent upon application to

THE REGISTRAR, UNIVERSITY OF KANSAS.
LAWRENCE, KANSAS.

THE
UNIVERSITY OF KANSAS

ANNUAL CATALOG

1915-1916

SECTION IV
SCHOOL OF ENGINEERING

UNIVERSITY CALENDAR.

Academic Year, 1915-'16.

January 1, Saturday—Close of Christmas recess.
January 24 to 28, Monday to Friday, inclusive—Semester examinations.
January 31, Monday—Beginning of second semester; enrollment in classes.
February 1, Tuesday—Beginning of class work in all departments.
February 22, Tuesday, Washington's birthday—Legal holiday.
April 3, Monday—Beginning of second half-semester.
April 21 to 24, Friday to Monday—Easter recess.
May 29 to June 2, Monday to Friday, inclusive—Semester examinations.
May 30, Tuesday, Decoration Day—Legal holiday.
June 4, Sunday, 8 p. m.—Baccalaureate sermon.
June 5, Monday, 3:30 p. m.—Commencement concert.
June 6, Tuesday, 10:30 a. m.—Alumni address.
June 6, Tuesday, 8 p. m.—Chancellor's reception.
June 7, Wednesday, 10 a. m.—Commencement exercises.
June 8, Thursday—Beginning of Summer Session.

Academic Year, 1916-'17.

September 11, 12, 13—Entrance examinations and registration.
September 12, 13, Tuesday, Wednesday—Enrollment in classes.
September 14—Beginning of class work in all departments.
September 15, Friday—General assembly and annual address, at 10 a. m.
November 20, Monday—Beginning of second half-semester.
November 30 to December 2, Thursday to Saturday—Thanksgiving recess, beginning Wednesday noon.
Christmas Recess—Saturday, December 16, to Monday, January 1, inclusive.
January 22 to 26, Monday to Friday, inclusive—Semester examinations.
January 29, Monday—Beginning of second semester; enrollment in classes.
January 30, Tuesday—Beginning of class work in all departments.
February 22, Thursday, Washington's birthday—Legal holiday.
April 2, Monday—Beginning of second half-semester.
April 6 to 9, Friday to Monday—Easter recess.
May 28 to June 1, Monday to Friday, inclusive—Semester examinations.
May 30, Wednesday, Decoration Day—Legal holiday.
June 3, Sunday, 8 p. m.—Baccalaureate sermon.
June 4, Monday, 3:30 p. m.—Commencement concert.
June 5, Tuesday, 10:30 a. m.—Alumni address.
June 5, Tuesday, 8 p. m.—Chancellor's reception.
June 6, Wednesday, 10 a. m.—Commencement exercises.
June 7, Thursday—Beginning of Summer Session.

STATE BOARD OF ADMINISTRATION OF EDUCATIONAL INSTITUTIONS.

Mr. ED. T. HACKNEY, *President,* Wellington	Term expires 1917
Mr. EDWARD W. HOCH, Marion	Term expires 1919
Mrs. J. M. LEWIS, Kinsley	Term expires 1917
Mr. Lee Harrison, *Secretary,* Cherokee.	

FACULTY.

FRANK STRONG, Ph. D., Chancellor of the University, and President of the Faculties.

PERLEY F. WALKER, M. M. E., Dean of the School of Engineering, and Professor of Mechanical Engineering.

EDGAR HENRY SUMMERFIELD BAILEY, Ph. D., Professor of Chemistry and Metallurgy.

CHARLES GRAHAM DUNLAP, Litt. D., Professor of English Literature.

ERASMUS HAWORTH, Ph. D., Professor of Geology and Mineralogy.

WILLIAM ALEXANDER GRIFFITH, Professor of Drawing and Painting.

EUGENIE GALLOO, A. M., Professor of Romance Languages and Literatures.

JAMES NAISMITH, M. D., Professor of Physical Education.

GEORGE CARL SHAAD, E. E., Professor of Electrical Engineering.

FREDERICK EDWARD KESTER, Ph. D., Professor of Physics.

HAMILTON PERKINS CADY, Ph. D., Professor of Chemistry.

B. J. DALTON,* B. C. E., Professor of Railway Engineering and Surveying.

HARRY ALVIN MILLIS, Ph. D., Professor of Economics.

HENRY WILBUR HUMBLE, A. M., Professor of Law.

HERBERT ALLEN RICE, C. E., Professor of Mechanics and Structural Engineering.

GOLDWIN GOLDSMITH, Ph. B., Professor of Architecture.

FRANK BURNETT DAINS, Ph. D., Professor of Chemistry.

CLEMENT C. WILLIAMS, C. E., Professor of Railway Engineering.

JOHN N. VAN DER VRIES, Ph. D., Professor of Mathematics.

CHARLES HAMILTON ASHTON, Ph. D., Professor of Mathematics.

ARTHUR C. TERRILL, E. M., Professor of Mining and Ore Dressing.

MARTIN EVERETT RICE, M. S., Associate Professor of Physics.

GEORGE JUSSEN HOOD, B. S., Associate Professor of Mechanical Drawing.

WILLIAM ASBURY WHITAKER, A. M., Associate Professor of Metallurgy.

F. H. SIBLEY, M. E., Associate Professor of Mechanical Engineering.

CHARLES A. HASKINS, B. S., Associate Professor of Sanitary Engineering.

FREDERICK NEWTON RAYMOND, A. M., Associate Professor of Rhetoric.

HERMAN CAMP ALLEN, Ph. D., Associate Professor of Chemistry.

CLARENCE ANTHONY JOHNSON, B. S., Associate Professor of Electrical Engineering.

WILLIAM COLEMAN MCNOWN, B. S., Associate Professor of Civil Engineering.

ALFRED HIGGINS SLUSS, B. S. in M. E., Associate Professor of Mechanical Engineering.

EDWIN FISKE STIMPSON, B. S., Assistant Professor of Physics.

CHARLES COCHRAN, B. S. in M. E., Assistant Professor of Mechanical Drawing.

FRANK EVERETT JONES, Assistant Professor of Pattern Making and Founding.

CLIFFORD CAUDY YOUNG, M. S., Assistant Professor of Chemistry.

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*On leave of absence.

HERBERT E. JORDAN, Ph. D., Assistant Professor of Mathematics.
THEODORE TOWNSEND SMITH, A. M., Assistant Professor of Physics.
F. W. BRUCKMILLER, A. B., Assistant Professor of Chemistry.
PAUL VANCE FARAGHER, Ph. D., Assistant Professor of Chemistry.
FRED REDDER HESSER,* B. S., Assistant Professor of Sanitary Engineering.
JOHN DILLER GARVER, B. S., Assistant Professor of Mechanical Engineering.
FRANK LOGAN BROWN, B. S., Assistant Professor of Mechanics.
EDWARD MAURICE BRIGGS, A. M., Assistant Professor of German.
CALVERT JOHNSON WINTER, Ph. B., Assistant Professor of Romance Languages.
H. A. ROBERTS, B. S., Assistant Professor of Civil Engineering.
JOSEPH E. WELKER, M. of C. E., Assistant Professor of Sanitary Engineering.
E. B. STOUFFER, Ph. D., Assistant Professor of Mathematics.
J. O. JONES, M. S., Assistant Professor of Hydraulics.
MAY GARDNER, A. B., Instructor in Romance Languages.
JOHN JEFFERSON WHEELER, A. B., Instructor in Mathematics.
HUBERT WILTFONG, Instructor in Forging.
LEON B. MCCARTY, A. M., Instructor in Rhetoric.
SARA G. LAIRD, A. B., Instructor in Rhetoric.
SOLOMON LEFSCHETZ, Ph. D., Instructor in Mathematics.
W. W. HAWKINS, A. M., Instructor in German.
HERMAN ADOLPH LORENZ, Instructor in Physical Education.
OSCAR ROCKLUND, Instructor in Foundry.
H. O. LICHTENWALTER, B. S., Instructor in Chemistry.
JOHN B. WHELAN, A. M., Instructor in Chemistry.
IVAN P. PARKHURST, B. S., Instructor in Chemistry.
CHARLES W. WHITE, Instructor in Machine Shop.
ARTHUR W. LARSEN, A. M., Instructor in Mathematics.
F. E. JOHNSON, E. E., Instructor in Electrical Engineering.
LAURENS E. WHITTEMORE, A. M., Instructor in Physics.
H. M. CURFMAN, B. S., Instructor in Electrical Engineering.
RICHARD L. GRIDER, E. M., Instructor in Mining Engineering.
KARL J. HOLZINGER, A. B., Instructor in Mathematics.
WILLIS G. WHITTEN, Assistant Instructor in Architectural Engineering.

ADMINISTRATIVE COMMITTEE.

P. F. WALKER, *Chairman*.
C. H. ASHTON, *Secretary*.
G. C. SHAAD.
H. A. RICE.
G. GOLDSMITH.
A. C. TERRILL.
M. E. RICE.
W. A. WHITAKER.
G. J. HOOD, *Chief Adviser of Freshmen*.

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*Resigned, March 1, 1916.

School of Engineering.

ORGANIZATION AND PURPOSE.

The School of Engineering was organized as a distinct school of the University in 1891. Prior to that time, for eighteen years, courses in engineering had been given under the collegiate department, mainly in the civil and electrical branches.

Technical work is given in eight departments, entirely within the control of the School. Departments of the College of Liberal Arts give courses in science, mathematics, language, and economics for engineering students. The curriculum includes definitely scheduled work leading to degrees in the main branches of engineering—civil, electrical, mechanical, mining, chemical, and architectural—with options under the civil in railway, structural, and sanitary engineering. Provision is made also for those who desire a training for business and administrative work based upon engineering.

The requirements for graduation emphasize the fact that a thorough grounding in the fundamental sciences, mathematics, and language is essential to successful engineering practice. This idea is then extended by introducing a moderate amount of specialized work in the Junior and Senior years, but the aim throughout is to develop the principles underlying technical engineering work rather than to make direct applications. It will be observed, moreover, that the requirements for graduation call for about twenty credit hours more than are required for a degree in pure science or arts, and this excess is in the nature of practice work in shop, field and drawing room. By these three methods the purpose of the School is shown, namely, to give the basis of a liberal education while providing for training in specialized professions, and to give sufficient practice work and familiarity with operating methods to enable the graduate to make himself useful to employers while he is gaining the broader experience necessary to a successful engineering career.

FIVE-YEAR COURSES.

In order to give greater emphasis to the value of general educational training for engineers, provision has been made for students so desiring to spend one year in the College of Arts and Sciences, and then to enter the School of Engineering for four years of study, making up a total of five years in the University. The conditions under which this may be done, and statements as to the degree conferred on completion of the work, are given in the following pages. The amount of technical work required is practically the same as in the regular four-year courses, but opportunities are offered for selecting a wider range of studies, and so providing for a broader education. Young men just graduating from high school are strongly urged to adopt this plan of procedure.

The leading characteristics of the several branches are noted in the following outlines:

Civil Engineering.

In the professional work emphasis is laid on surveying and field methods; on mechanics and the application to the designing of steel and concrete structures; on railway location and construction; on hydraulics, and the application to irrigation, canal and power work; and on water supply and other municipal problems, including pavement and highway construction. Particular emphasis is given to the training of men for the three important branches: namely, railway, structural, and sanitary engineering. For each of these a special schedule for the work of the Senior year will be found in the following pages.

Electrical Engineering.

The specialized studies under this heading follow the fundamental work in physics and machine elements. They give emphasis to the methods of design, construction and operation of electrical equipment of all kinds as employed for the production, distribution and application of electrical energy, and in telephone service. Much emphasis is laid on the fundamental principles of mechanics and electricity, and on laboratory practice in handling standard apparatus. Original investigation is encouraged in every way possible.

Mechanical Engineering.

In the professional work especial emphasis is placed on machine construction and design, the properties of materials, power generation with heat engines, and general manufacturing methods. Options in the Senior year permit specialization to a limited degree, so that the student may give his attention to that line in which he develops the greatest interest. The aim is to give the training which will permit the graduate to perform successfully the work required of the technical designer and administrator in manufacturing industries.

Mining Engineering.

In this branch professional work depends more directly upon chemistry and geology, and more work is required in these fundamentals than in the other branches already mentioned. Following this the professional work is of two kinds—first, that which bears upon the actual development and operation of mines, including the methods of administration; second, that which bears upon the treatment of the mine product in the various milling and smelting processes. It is the aim to emphasize the scientific principles involved, and so make it possible for the graduate to begin his later specialization successfully in any one of the many lines of work within the broad range of the mining industry.

Chemical Engineering.

In this branch opportunity is given for specialization in technical chemistry, with the aim to combine the ability to perform chemical work with training in the fundamentals of engineering. It is expected that students are fitting themselves for positions as chemists and superintendents of manufacturing plants where the work is based on chemical science. These include many industries, such as those involving iron and steel, smelting, refining, bleaching and dyeing processes, and the manufacture of many specialized products.

Architectural Engineering.

Much is included in this branch which involves the artistic as well as the utilitarian in building design and construction. It is recognized that architecture is essentially a fine art, but that this should be combined with the scientific and technical training which will enable the graduate to deal with the engineering side of construction work. The professional work given includes thorough instruction in the history and theory of architecture and in the principles of design. It is the aim to give such training as will enable the graduate to render efficient service while he is supplementing his school training by experience gained in office practice.

Engineering and Administrative Science.

Arrangements have been perfected whereby the College departments of economics, history, and sociology coöperate with the School of Engineering in offering work to fit men for positions in the administrative offices of manufacturing companies and in the transportation departments of railroads. Both the College student and the engineering student may profit by the plan.

The student who has started in engineering may begin to vary the regular schedule of studies during his second year, and may, under the advice of a committee of the Faculty, arrange to substitute from twenty to twenty-five hours of courses in the College departments indicated in place of the more highly specialized engineering work. The student is trained, therefore, in all the fundamentals of engineering, and should be well fitted to take positions in offices where the work depends largely upon technical phases of the industry in question. A more detailed statement of the work will be found in the following pages under the heading "Curriculum."

DEGREES GRANTED.

All graduates of the School of Engineering are admitted to the degree of bachelor of science in engineering or bachelor of science. The first is given to those who have completed the work laid out on the regular four-year plan, based on entrance from the accredited high schools. The second is given to those who enter the School of Engineering after having completed thirty hours of work in the College of Arts and Sciences, and to those who complete the work offered in engineering and administrative science.

All graduates of the School of Engineering may enter the Graduate School of the University and become candidates for the degree of master of science under the regulations there in force.

Graduates in engineering from this school, and those who have received the master's degree for advanced study in engineering under the Graduate School, are eligible to the professional degrees of Civil Engineer, Electrical Engineer, Mechanical Engineer, Engineer of Mines, Chemical Engineer, and Architectural Engineer, whichever is appropriate to the undergraduate work taken. Candidates for these degrees must have spent at least three years of actual time in professional practice in positions of responsibility, in the design, construction, or operation of professional works, and must furnish detailed and satisfactory evidence as to the nature and extent of this practice.

The candidate must submit a thesis, accompanied by detailed explanations, drawings, specifications, estimates, etc., and embodying the results of his own work or observation. If approved, the thesis, with all accompanying material, becomes the property of the University.

The thesis for any professional degree must be delivered to the Dean of the School of Engineering on or before May 15.

ADMISSION.

By act of the state legislature, all graduates of accredited high schools in Kansas are admitted to the Freshman class without examination.

Graduates of other preparatory schools will be admitted on such conditions as the Faculty may impose.

For the guidance of prospective students who desire to prepare themselves without graduating from accredited high schools an outline of preparatory studies which has been followed for many years is given below. A total of fifteen units must be offered for admission.

ENGLISH.—Rhetoric and English literature, 3 or 4 units. Three units required.

MATHEMATICS.—Elementary algebra, 1½ units; plane geometry, 1 unit; solid geometry, ½ unit; plane trigonometry, ½ unit; advanced algebra, ½ unit. Three units required to prepare for the regular engineering courses.

FOREIGN LANGUAGES.—Latin, 1, 2, 3 or 4 units; Greek, 1, 2, 3 or 4 units; German, 1, 2, 3 or 4 units; French, 1, 2, 3 or 4 units; Spanish, 1 or 2 units. Two units at entrance and ten hours of German, French or Spanish in the University complete the requirements for graduation.

PHYSICAL SCIENCES.—Physical geography, 1 or ½ unit; physics, 1 unit; chemistry, 1 unit. One unit required.

BIOLOGICAL SCIENCES.—Botany, 1 unit; zoology, 1 unit; physiology, 1 or ½ unit; biological science, 1 unit.

HISTORY AND SOCIAL SCIENCE.—Greek and Roman history, 1 unit; medieval and modern history, 1 unit; English history, 1 unit; American history, 1 unit; economics, 1 or ½ unit; civics, ½ unit. Three units recommended.

MANUAL TRAINING.—Woodwork, forging, and machine tool work, 2 units; free-hand or mechanical drawing, 1 unit.

MISCELLANEOUS.—Stenography, ½ unit; bookeeping, ½ unit; commercial law, ½ unit; commercial geography, ½ unit; agriculture, ½ or 1 unit; psychology, ½ unit; advanced arithmetic if taken after one year of algebra, ½ unit. Not more than two units are allowed.

Entrance Examinations.

Candidates for admission who are not graduates of accredited Kansas high schools may offer themselves for examinations in subjects usually embraced in the high-school curriculum. Whenever a candidate has thus secured credit for the equivalent of the work included in the curriculum of the accredited high school he will be admitted to the Freshman class.

A schedule of these examinations will be found on page 45 of the General Information Section of the Catalog.

Inadequate Preparation.

When a student by his current work shows insufficient preparation for any course, he may be required to make good such deficiency in any manner prescribed by his instructor and approved by the Dean of the School.

Admission to Advanced Standing.

The regulations governing admission to advanced standing are administered by a committee of the University Senate, which examines into the merits of each case presented to it, and either credits the applicant with a certain rank or recommends him to the head of departments for advanced credit or examination.

Application for such advanced standing must be made at the time of matriculation.

Undergraduates from other institutions must present certificates of honorable dismissal, or other satisfactory evidence of good character.

Admission to advanced standing may be secured in two ways:

BY EXAMINATION. A candidate may be admitted to the Sophomore, Junior or Senior class, if he appears on examination to be prepared in the following studies: (1) In the studies required for admission to the Freshman class. (2) In all such studies as he would have pursued if he had entered at the beginning of the course, or such as are substantially equivalent thereto.

All applications for examination for advanced standing must be made during the opening week of the first term. Credit for work done in preparatory schools will be given upon examination only.

BY CERTIFICATE. Graduates or students from the higher classes of other engineering colleges may be admitted to advanced standing upon presentation of a certificate stating in detail the work done, under such conditions as the Faculty may determine to be just in each case, upon consideration of the applicant's previous course of study and of the evidence he presents of his proficiency in that course. Application for credits toward advanced standing in technical subjects should be made to the Dean of the School of Engineering.

Foreign Language Required for Graduation.

The total amount of work in foreign language which is required for graduation, both high-school credits and courses taken after entering the University being considered together, must be equivalent to twenty hours in University courses, of which at least ten hours shall be in one modern foreign language. Each unit of entrance credit counts as five hours.

The curriculum (see page 14) calls for ten hours of modern foreign language in the Freshman year. In any case where a student is able to satisfy the foreign language requirements by taking a lesser number of hours than ten, he may substitute other University work for the number of hours remaining.

Special Students.

Opportunity is given in the School of Engineering for the admission of persons of mature years who desire to pursue some special lines of work, without following any prescribed course of study or becoming candidates for a degree.

The admission of such special students is directly under the control of the Dean of the School of Engineering, whose certificate of acceptance must be presented to the Registrar before registration. Applicants for admission as special students must present satisfactory evidence of proper preparation for the courses desired, and must also meet other requirements as fixed by the Faculty.

Special students are subject to the same regulations as are regular students with regard to the quality of work performed and attendance at recitations and examinations, but not as to number of courses to be pursued.

If a special student later becomes a candidate for a degree, the credits he has received while enrolled as a special student will not be allowed to count towards this degree, except by the approval of the Faculty. In no case may a student be granted a degree until he has been enrolled for one year as a regular student.

Any one regularly enrolled in another school of the University may be admitted as a special student to engineering classes, but all applications for such enrollment must be accompanied by the recommendation of the dean of the school concerned.

REGISTRATION.

All candidates for admission having certificates from accredited schools and all students of the University intending to pursue their studies during the ensuing year should present themselves for registration at the University on September 11, 12 or 13, 1916.

Registration at a later date will be permitted only on the payment of a fee of one dollar.

ENROLLMENT.

After registration has been completed with the Registrar and fees have been paid, students should apply to the Dean for enrollment in their classes. Enrollment the first semester occurs September 12 and 13, 1916, and on the first day of the second semester.

Enrollment at a later date will be permitted only on the payment of a fee of one dollar.

Enrollment Regulations.

The amount of work to be carried by students is expected to conform to the lists printed in the curriculum on the following pages. The number of hours there indicated may not be exceeded unless by express permission of the Dean. Students who have shown inability to carry the full schedule, or who plan to devote time to remunerative work outside of school, are frequently obliged to restrict the number of hours carried to fifteen or even less. Those who can not carry a minimum of fourteen hours are advised to discontinue work for the degree, since credits secured at that rate would necessitate spending five years to complete the four-year course, and to take a longer time than that is usually unwise.

Students are assigned to groups, each group being in the charge of a member of the Faculty who acts as adviser at enrollment and during the year. Students above the Freshman class are assigned to groups according to departments in which they are specializing. Advisers are expected to retain oversight over their charges, and reports on the current work of students are made to them at monthly intervals.

FEES AND EXPENSES.

Matriculation fee, for residents of the state	$5.00
for nonresidents	10.00
Incidental fee per school year, for residents of the state	10.00
for nonresidents	20.00
Diploma fee, at graduation	5.00

Cost of Materials.

In all laboratory and shop courses the student is charged for the materials and supplies he consumes in his work. These charges are payable in advance at the office of the University Registrar by the purchase of a book of coupons receivable for materials in any course, or by the payment of a fixed amount for a course in which the material can not be issued to each student individually. A schedule of these fixed fees, varying from 50 cents to $4, is posted in Marvin Hall and in the office of the University Registrar. In those courses where a large amount of material is used by the student and paid for with coupons, the total cost for any one course may reach or occasionally exceed $10.

Those students taking summer field work will be charged the actual cost of living and incidental expenses.

Cost of Drawing Instruments.

The ability to make standard office drawings in connection with the designing of machines and structures of all kinds is a necessary part of an engineer's attainments. The drawing practice begins in the Freshman year, and for all excepting chemical engineering students continues during the three years following. This fact makes necessary for each student the ownership of a set of drafting instruments of standard quality. In order to make this matter sure, and protect students from any who might wish to sell inferior grades, the School prescribes the kinds which may be used. During past years the lowest-priced complete set, in its case, has been one obtainable from Lawrence dealers for $13.50. Dealers in other towns where there is little competition have usually sold equivalent sets at a price several dollars higher. Because of scarcity due to diminished importation of German-made instruments, the prices for the school year 1916-'17 will be greatly advanced, and students entering school that year should plan to expend from $22 to $25 for the regulation sets, together with other necessary equipment for the drawing classes.

Expense for Inspection Trips.

Students should make provision for expenses of about $40 in the Junior or Senior year, or both, for inspection trips to engineering works. (See "Inspection Trips" at the end of "Description of Courses.")

ENGINEERING EXTENSION WORK.

CORRESPONDENCE COURSES.

Through the University Extension Division the School of Engineering offers work by correspondence. By this method it is possible for a student to secure instruction in many of the general courses required for the degree in engineering and in a few of the technical courses.

In cases where a group of six or more persons may be formed, arrangements have been made whereby the Extension Division will send an instructor at stated intervals to meet the class. By this means many of the technical courses are being offered which are not offered directly through correspondence. An additional fee is required for work thus given. In this manner it is possible for young men to do a large portion of the work required for a degree, but the School of Engineering requires that at least one year of work shall be done in residence.

Work is being offered also of a grade below that required for regular credit, in what are termed Vocational Courses. By means of these courses, effort is made to extend the facilities of the University to a large group of young men who have not had time or opportunity to fit themselves for regular engineering work. When possible the work is carried on in coöperation with the school authorities of cities and towns and with industrial organizations which employ boys in considerable numbers.

For further details, see "University Extension Division."

TECHNICAL SOCIETIES.

TAU BETA PI. Kansas Alpha Chapter of the honorary engineering society of Tau Beta Pi was installed in December, 1914. Members are from the Senior and Junior classes, chosen under regulations which require that all who are elected shall have standing in the upper fourth of their class. It is governed entirely by undergraduates.

Departmental Student Societies.

In each of the six departments in which a complete course of study leading to graduation is scheduled there is a well-organized society holding regular meetings at weekly or biweekly intervals. At these meetings technical addresses are given or topics from the current press discussed. The architectural, chemical, and civil engineering societies are local in their character. The electrical, mechanical, and mining organizations are connected with the respective national engineering societies. More detailed information is given on pages 42 and 43 of the General Information Section of the Catalog.

CURRICULUM

Leading to the Degree of Bachelor of Science in Engineering.

The work required for the degree of bachelor of science in the School of Engineering is in large measure prescribed. The following schedules show the variations among the several branches. Students are required to enroll for the work in the order given, excepting a few of the specialized courses in the Junior and Senior years, which do not depend directly on preceding courses.

The work of the Freshman year is very nearly the same for all students, so that a choice among the several branches need not be made at the start, except in the case of architectural engineering. A slight modification of the shop courses in machine construction makes it desirable for those planning to take civil and mining engineering to make definite decision at the end of the first semester.

COURSES COMMON TO ALL LINES.‡

FRESHMAN YEAR.

FIRST SEMESTER, 17 hours credit.*

Course number.	*Subject.*	*Hours credit.*
Mathematics 2	College Algebra	3
Mathematics 3	Plane Trigonometry	2
German, French or Spanish†	(Course as approved)	5
English 1 E	Rhetoric I	3
Engineering Drawing 1	Free-hand Drawing	1⅓
Engineering Drawing 2	Mechanical Drawing	⅔
Engineering Drawing 4, or Machine Construction 1 and 2	Machine Drawing, or Foundry Practice and Pattern Making	2
Engineering 1	Engineering Lectures.	
Physical Education 1	Gymnasium, 3 periods per week.	

SECOND SEMESTER, 17 hours credit.

Course number.	*Subject.*	*Hours credit.*
Mathematics 4 E	Analytic Geometry	5
German, French, or Spanish†	(Course as approved)	5
English 2 E	Rhetoric II	2
Engineering Drawing 3	Descriptive Geometry	3
Engineering Drawing 4, or Machine Construction 1 and 2, or Machine Construction 3 and 4	Machine Drawing, or Foundry, Forge and Machine Shop Practice as assigned	2
	Gymnasium, 3 periods per week.	

CIVIL ENGINEERING.

SOPHOMORE YEAR.

FIRST SEMESTER, 18½ hours credit.

Course number.	*Subject.*	*Hours credit.*
Civil Engineering 1	Elementary Surveying	3
Mathematics 5 E	Calculus I	5
Physics 1 E	General Physics	5
Geology 1	Elementary Geology	5
	Technical Report I	½

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*THE HOUR OF CREDIT.—The amount of work required to complete a course is measured in "hours." One hour in the School of Engineering represents an amount of work which is estimated to require three hours per week, throughout a semester, of the time of a student of average ability. These three hours may be divided in any ratio between class attendance and outside work, most courses being in the ratio of one hour in class to two hours of outside preparation; or two hours in class to one hour of outside preparation or report writing; or all three required in class with no outside preparation. In the descriptions of courses the number of hours credit for each is stated.

†The foreign language chosen is carried regularly throughout the year, five hours each semester. The selection of the language courses will depend on the amount and kind of language offered at entrance. Students offering more than two units at entrance may be allowed to substitute other nontechnical courses for the foreign language, provided they complete ten hours in one modern language.

‡Excepting Architectural Engneering. For that see page 30.

Second Semester, 16½ hours credit.

Course number.	*Subject.*	*Hours credit.*
Civil Engineering 4	Railway Surveying	2
Civil Engineering 2	Higher Surveying	3
Mathematics 6 E	Calculus II	3
Physics 2 E	General Physics	5
Mechanical Engineering 5	Engines and Boilers	3
	Technical Report II	½

Summer Work.

Civil Engineering 3	Field Work, 4 weeks.

JUNIOR YEAR.

First Semester, 18 hours credit.

Civil Engineering 55	Railway Surveying	4
Civil Engineering 51	Cartography	2
Mechanics 50	Mechanics	5
Chemistry 2	Advanced Inorganic Chemistry	4
English 59	Advanced Composition	3

Second Semester, 17½ hours credit.

Civil Engineering 57	Railway Location	3
Mechanics 51	Strength of Materials	4
Mechanics 52	Testing Laboratory	1
Mechanics 53	Graphic Statics	2
Mechanics 55	Hydraulics	3
Mechanics 56	Hydraulic Laboratory	1
Chemistry 5 E	Engineering Chemistry	3
	Technical Report III	½

SENIOR YEAR.

First Semester, 17½ hours credit.

Civil Engineering 61	Stresses in Framed Structures	5
Civil Engineering 64	Masonry	2
Civil Engineering 65	Reinforced Concrete	3
Civil Engineering 70	Sanitary Engineering I	3
	Optional	3
	Thesis	1
	Technical Report IV	½

Second Semester, 17 hours credit.

Civil Engineering 62	Bridge Design	4
Civil Engineering 75	Roads and Pavements	2
Engineering 52	Industrial Administration	3
Mechanics 57	Cement Laboratory	1
Civil Engineering 66	Reinforced Concrete Design	1
	Optional	4
	Thesis	2

One extended inspection trip is required during the Junior or Senior year.

Railway Engineering Option.

SENIOR YEAR.

First Semester, 18½ hours credit.

Civil Engineering 61	Stresses in Framed Structures	5
Civil Engineering 64	Masonry	2
Civil Engineering 65	Reinforced Concrete	3
Civil Engineering 70	Sanitary Engineering I	3
Civil Engineering 58	Railway Terminals and Signaling	2
Electrical Engineering 60	Elements of Electrical Engineering	3
	Technical Report IV	½

Second Semester, 17 hours credit.

Civil Engineering 62	Bridge Design	4
Civil Engineering 75	Roads and Pavements	2
Mechanics 57	Cement Laboratory	1
Civil Engineering 59	Railway Construction and Maintenance	3
Engineering 52	Industrial Administration	3
Civil Engineering 66	Reinforced Concrete Design	1
	Thesis	3

Structural Engineering Option.

SENIOR YEAR.

FIRST SEMESTER, 18½ hours credit.

Course number.	*Subject.*	*Hours credit.*
Civil Engineering 61	Stresses in Framed Structures	5
Civil Engineering 64	Masonry	2
Civil Engineering 65	Reinforced Concrete	3
Civil Engineering 70	Sanitary Engineering I	3
Mechanics 54	Engineering Materials	2
Electrical Engineering 60	Elements of Electrical Engineering	3
	Technical Report IV	½

SECOND SEMESTER, 17 hours credit.

Course number.	*Subject.*	*Hours credit.*
Civil Engineering 62	Bridge Design	4
Civil Engineering 75	Roads and Pavements	2
Mechanics 57	Cement Laboratory	1
Civil Engineering 67	Higher Structures	3
Engineering 67	Industrial Administration	3
Civil Engineering 66	Reinforced Concrete Design	1
	Thesis	3

Municipal and Sanitary Option.

JUNIOR YEAR.

FIRST SEMESTER, 17 hours credit.

Course number.	*Subject.*	*Hours credit.*
Civil Engineering 73	Sanitary Science	2
Mechanics 50	Mechanics	5
Chemistry 2	Advanced Inorganic Chemistry	4
English 59	Advanced Composition	3
Electrical Engineering 60	Electrical Engineering	3

SECOND SEMESTER, 18½ hours credit.

Course number.	*Subject.*	*Hours credit.*
Civil Engineering 74	Waste and Garbage Disposal	1
Civil Engineering 75	Roads and Pavements	2
Civil Engineering 52	City Planning	2
Mechanics 51	Strength of Materials	4
Mechanics 52	Testing Laboratory	1
Chemistry 3	Qualitative Analysis	4
Mechanics 55	Hydraulics	3
Mechanics 56	Hydraulic Laboratory	1
	Technical Report III	½

SENIOR YEAR.

FIRST SEMESTER, 17½ hours credit.

Course number.	*Subject.*	*Hours credit.*
Civil Engineering 61	Stresses in Framed Structures	4
Civil Engineering 64	Masonry	2
Civil Engineering 70	Sanitary Engineering I	3
Civil Engineering 65	Reinforced Concrete	3
Chemistry 56 E	Water Analysis	5
	Technical Report IV	½

SECOND SEMESTER, 17 hours credit.

Course number.	*Subject.*	*Hours credit.*
Engineering 52	Industrial Administration	3
Civil Engineering 72	Sanitary Design	5
Civil Engineering 71	Sanitary Engineering II	4
Mechanics 57	Cement Laboratory	1
Civil Engineering 66	Reinforced Concrete Design	1
	Thesis	3

One extended inspection trip is required during the Junior or the Senior year.

ELECTRICAL ENGINEERING.

SOPHOMORE YEAR.

FIRST SEMESTER, 17½ hours credit.

Course number.	*Subject.*	*Hours credit.*
Mathematics 5 E	Calculus I	5
Physics 1 E	General Physics	5
Chemistry 2	Advanced Inorganic Chemistry	4
Mechanical Engineering 1	Machine Drafting	1
Machine Construction 3	Forging	1
Machine Construction 5	Bench Work	1
	Technical Report I	½

SECOND SEMESTER, 18½ hours credit.

Course number.	*Subject.*	*Hours credit.*
Mechanical Engineering 3	Elementary Machine Design	3
Mechanical Engineering 4	Steam Machinery	2
Mathematics 6 E	Calculus II	3
Physics 2 E	General Physics	5
Chemistry 3	Qualitative Analysis	4
Machine Construction 6	Machine Tool Work I	1
	Technical Report II	½

JUNIOR YEAR.

FIRST SEMESTER, 17½ hours credit.

Electrical Engineering 50	Dynamo Machinery	3
Electrical Engineering 54	Electrical Laboratory	1½
Mechanics 50	Mechanics	5
Physics 52	Theory of Electricity	3
Physics 60 E	Electrical Measurements I	1½
Mechanical Engineering 52	Heat Engine Theory	3
	Technical Report III	½

SECOND SEMESTER, 18 hours credit.

Electrical Engineering 51	Theory of Alternating Currents	5
Electrical Engineering 55	Electrical Laboratory	1½
Mechanical Engineering 53	Mechanics of Heat Engines	2
Mechanics 51	Strength of Materials	4
Mechanics 52	Testing Laboratory	1
English 59	Advanced Composition	3
Physics 61 E	Electrical Measurements II	1½

SENIOR YEAR.

FIRST SEMESTER, 17½ hours credit.

Electrical Engineering 52	Advanced Dynamo Machinery	5
Electrical Engineering 56	Advanced Electrical Laboratory	1½
Civil Engineering 50	Surveying	3
Mechanical Engineering 65	Power Laboratory	1½
Chemistry 64	Physical Chemistry I	5
	Thesis	1
	Technical Report IV	½

SECOND SEMESTER, 16½ hours credit.

Electrical Engineering 58	Electric Power Transmission	5
Electrical Engineering 57	Illuminating Engineering	2½
Engineering 52	Industrial Administration	3
Electrical Engineering 61	Thesis	3
	Optional	3

One extended inspection trip is required during the Junior or the Senior year.

MECHANICAL ENGINEERING.

SOPHOMORE YEAR.

FIRST SEMESTER, 18½ hours credit.

Course number.	*Subject.*	*Hours credit.*
Mechanical Engineering 1	Machine Drafting	1
Mechanical Engineering 2	Mechanism	3
Mathematics 5 E	Calculus I	5
Chemistry 2	Advanced Inorganic Chemistry	4
Economics 1 E, or German, French, or Spanish	Elements of Economics, or (Advanced Language course as approved)	3
Machine Construction 3	Forging	1
Machine Construction 5	Bench Work	1
	Technical Report I	½

SECOND SEMESTER, 17½ hours credit.

Mechanical Engineering 6	Steam Engineering	4
Mathematics 6 E	Calculus II	3
Physics 1 E	General Physics	5
Chemistry 5 E	Engineering Chemistry	3
Machine Construction 6 Machine Construction 7	Machine Tool Work I Machine Tool Work II	2
	Technical Report II	½

JUNIOR YEAR.

FIRST SEMESTER, 18 hours credit.

Mechanical Engineering 51	Thermodynamics	3
Mechanical Engineering 64	Mechanical Laboratory	1
Physics 2 E	General Physics	5
Mechanics 50	Mechanics	5
Metallurgy 61 E	Metallurgy I	3
Machine Construction 8	Advanced Machine Shop Practice	1

SECOND SEMESTER, 16 hours credit.

Course number.	*Subject.*	*Hours credit.*
Mechanical Engineering 50	Machine Design	4
Mechanical Engineering 54	Heating Ventilating and Cooking	2
Mechanical Engineering 60	Shop Methods	1½
Mechanics 51	Strength of Materials	4
Mechanics 52	Testing Laboratory	1
English 59	Advanced Composition	3
	Technical Report	½

SUMMER WORK.

Mechanical Engineering 68	Summer Vacation Work.	

SENIOR YEAR.

FIRST SEMESTER, 18 hours credit.

Mechanical Engineering 56	Steam Engine and Turbine Design I	3
Mechanical Engineering 67	Thesis	1
Mechanics 55	Hydraulics	3
Mechanics 56	Hydraulic Laboratory	1
Engineering 51	Manufacturing	2
Electrical Engineering 50	Dynamo Machinery	3
Electrical Engineering 54	Electrical Laboratory	1½
Mechanical Engineering	Option (see below)	3
	Technical Report	½

SECOND SEMESTER, 16 hours credit.

Mechanical Engineering 66	Heat Engine Laboratory	1½
Mechanical Engineering 67	Thesis (continued)	2
Civil Engineering 50	Surveying	3
Engineering 52	Industrial Administration	3
Electrical Engineering 53	Alternating Currents	3
Electrical Engineering 55	Electrical Laboratory	1½
Mechanical Engineering	Option (see below)	3

Power Option.

FIRST SEMESTER.

Mechanical Engineering 58	Internal Combustion Motors I, or	3
Mechanics 58	Hydraulic Power	

SECOND SEMESTER.

Mechanical Engineering 57	Steam Engine and Turbine Design II, or	3
Mechanical Engineering 59	Internal Combustion Motors II	

Manufactures Option.

FIRST SEMESTER.

Mechanical Engineering 55	Refrigeration, or	3
Mechanical Engineering 61	Structural Design	

SECOND SEMESTER.

Mechanical Engineering 58	Internal Combustion Motors, or	3
Mechanical Engineering 62	Industrial Plant Design	

One extended inspection trip is required during the Junior or the Senior year.

MINING ENGINEERING.

SOPHOMORE YEAR.

FIRST SEMESTER, 18½ hours credit.

Course number.	*Subject.*	*Hours credit*
Mathematics 5 E	Calculus	5
Geology 1	Elementary Geology	5
Chemistry 2	Advanced Inorganic Chemistry	5
Civil Engineering 1	Elementary Surveying	3
	Technical Report I	½
	Mining Journal.	

SECOND SEMESTER, 18½ hours credit.

Mining Engineering 1	Mining Methods	1
Physics 1 E	General Physics	5
Chemistry 3	Qualitative Analysis	4
Civil Engineering 2	Higher Surveying	3
Mineralogy 10	Elementary Mineralogy	5
	Technical Report II	½
	Mining Journal.	

JUNIOR YEAR.

FIRST SEMESTER, 18½ hours credit.

Course number.	*Subject.*	*Hours credit.*
Mining Engineering 50	Mine Surveying	1
Mechanical Engineering 4	Steam Machinery	2
Chemistry 54	Quantitative Analysis	5
Mechanics 50	Mechanics	5
Physics 2 E	Physics	5
	Technical Report III	½
	Mining Journal.	

SECOND SEMESTER, 18 hours credit.

Mining Engineering 51	(*a*) Excavation and Explosives (*b*) Practice Work	2
Mining Engineering 52	Mining Law	1
Metallurgy 64 E	Iron and Steel	2
Metallurgy 57	Assaying	5
Mechanics 51	Strength of Materials	4
Mechanics 52	Testing Laboratory	1
English 59	Advanced Composition	3
	Mining Journal.	

Metal Mining Option.

SENIOR YEAR.

FIRST SEMESTER, 16½ hours credit.

Mining Engineering 53	Ore Dressing I	2
Mining Engineering 54	Metal Mining	2
Mining Engineering 55	Mining Hydraulics	2
Mining Engineering 56	Mine Plant and Mill Design I	2
Geology 54	Economic Geology I	3
Electrical Engineering 60	Electrical Engineering	3
	Optional	2
	Technical Report IV	½
	Mining Journal.	

SECOND SEMESTER, 18 hours credit.

Mining Engineering 57	Mine Administration	1
Mining Engineering 58	Ore Dressing II	4
Mining Engineering 59	Mine Examinations and Reports	1
Mining Engineering 60	Thesis	2
Geology 55	Economic Geology II	5
Metallurgy 62 E	Metallurgy	3
Engineering 52	Industrial Administration	2
	Mining Journal.	

Coal Mining Option.

SENIOR YEAR.

FIRST SEMESTER, 17½ hours credit.

Mining Engineering 53	Ore Dressing	2
Mining Engineering 55	Mining Hydraulics	2
Mining Engineering 56	Mine Plant and Mill Design I	2
Mining Engineering 61	Coal Mining I	2
Geology 54	Economic Geology I	3
Electrical Engineering 60	Electrical Engineering	3
Geology 50	Historical Geology I	3
	Technical Report IV	½
	Mining Journal.	

SECOND SEMESTER, 17 hours credit.

Mining Engineering 57	Mine Administration	1
Mining Engineering 59	Mine Examinations and Reports	1
Mining Engineering 60	Thesis	2
Mining Engineering 62	Coal Mining II	3
Geology 55	Economic Geology II	5
Engineering 52	Industrial Administration	2
	Optional	3
	Mining Journal.	

CHEMICAL ENGINEERING.

SOPHOMORE YEAR.

FIRST SEMESTER, 17½ hours credit.

Course number.	*Subject.*	*Hours credit.*
Chemistry 2	Advanced Inorganic Chemistry	5
Mathematics 5 E	Calculus I	5
Physics 1 E	General Physics	5
Mechanical Engineering 1	Machine Drafting	1
Machine Construction 3	Forging	1
	Technical Report I	½

SECOND SEMESTER, 17½ hours credit.

Chemistry 3	Qualitative Analysis	5
Physics 2 E	General Physics	5
Mineralogy 10	Elementary Mineralogy I	5
Machine Construction 5	Bench Work	2
Machine Construction 6	Machine Tool Work I	
	Technical Report II	½

JUNIOR YEAR.

FIRST SEMESTER, 18½ hours credit.

Chemistry 4	Organic Chemistry I	5
Chemistry 54	Quantitative Analysis I	5
Mechanics 50	General Mechanics	5
English 59	Advanced Composition	3
	Technical Report III	½

SECOND SEMESTER, 18 hours credit.

Chemistry 51 A	Industrial Chemistry; Inorganic	3
Chemistry 55	Quantitative Analysis II	5
Chemistry 60	Organic Chemistry II	5
Mechanics 51	Strength of Materials	4
Mechanics 52	Testing Laboratory	1

SENIOR YEAR.

FIRST SEMESTER, 17½ hours credit.

Chemistry 51 B	Industrial Chemistry; Organic	3
Chemistry 64	Physical Chemistry I	5
Metallurgy 61 E	Metallurgy I	3
Metallurgy 65 E	General Metallurgy	2
	Optional from Chemistry Department, 4 hours or Optional 2 hours and Thesis 2 hours	4
	Technical Report IV	½

SECOND SEMESTER, 17 hours credit.

Chemistry 65	Physical Chemistry II	5
Metallurgy 57	Assaying	3
Metallurgy 62	Metallurgy II	3
Engineering 52	Industrial Administration	3
	Thesis	3

One extended inspection trip is required during the Senior year.

ARCHITECTURAL ENGINEERING.

FRESHMAN YEAR.

FIRST SEMESTER, 17 hours credit.

Course number.	*Subject.*	*Hours credit.*
Architectural Engineering 1	Free-hand Drawing I	2
Mathematics 2	College Algebra	3
Mathematics 3	Plane Trigonometry	2
German, French or Spanish*	(Course as approved)	5
English 1 E	Rhetoric I	3
Engineering Drawing 1 and 2	Mechanical Drawing	2
Engineering 1	Engineering Lectures.	
Physical Education 1	Gymnasium, 3 periods per week.	

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*French preferred.

SECOND SEMESTER, 17 hours credit.

Course number.	*Subject.*	*Hours credit.*
Architectural Engineering 2	Free-hand Drawing II	2
Mathematics 4 E	Analytic Geometry and Theory of Equations	5
German, French or Spanish	(Course as approved)	5
English 2 E	Rhetoric II	2
Engineering Drawing 3	Descriptive Geometry	3
Physical Education 2	Gymnasium, 3 periods per week.	

SOPHOMORE YEAR.

FIRST SEMESTER, 18½ hours credit.

Architectural Engineering 3	Architectural Design I	3
Architectural Engineering 5	History of Architecture I	3
Architectural Engineering 7	Architectural Drawing I	1
Architectural Engineering 9	Shades and Shadows	1
Mathematics 5 E	Calculus I	5
Physics 1 E	General Physics	5
	Technical Report I	½

SECOND SEMESTER, 17½ hours credit.

Architectural Engineering 4	Architectural Design II	3
Architectural Engineering 6	History of Architecture II	3
Architectural Engineering 8	Architectural Drawing II	1
Physics 2 E	General Physics	5
Mathematics 6 E	Calculus II	3
Mechanical Engineering 4	Steam Machinery	2
	Technical Report II	½

JUNIOR YEAR.

FIRST SEMESTER, 18½ hours credit.

Architectural Engineering 50	Architectural Design III	3
Architectural Engineering 56	History of Architecture III	2
Architectural Engineering 58	Building Construction I	3
Architectural Engineering 62	Architectural Drawing III	1
Chemistry 2	Advanced Inorganic Chemistry	4
Mechanics 50	Mechanics	5
	Technical Report III	½

SECOND SEMESTER, 17½ hours credit.

Architectural Engineering 51	Architectural Design IV	3
Architectural Engineering 59	Building Construction II	3
Architectural Engineering 61	Building Sanitation	1
Architectural Engineering 63	Architectural Drawing IV	1
Mechanics 51	Strength of Materials	4
Mechanics 52	Testing Laboratory	1
Mechanics 53	Graphic Statics	2
Mechanical Engineering 54	Heating and Ventilation	2
	Technical Report IV	½

SENIOR YEAR.

FIRST SEMESTER, 19 hours credit.

Architectural Engineering 52	Architectural Design V	2
Civil Engineering 61	Stresses in Framed Structures	5
Civil Engineering 65	Reinforced Concrete	3
Economics 1 E	Elements of Economics	3
English 59	Advanced Composition	3
Electrical Engineering 64	Electrical Engineering for Architects	3

SECOND SEMESTER, 15 hours credit.

Architectural Engineering 53	Architectural Design VI	2
Architectural Engineering 57	Thesis	3
Architectural Engineering 65	Steel Construction	3
Mechanics 57	Hydraulic Cement	1
Engineering 52	Industrial Administration	3
Civil Engineering 50	Surveying	3

One extended inspection trip is required during the Junior or the Senior year.

ENGINEERING AND ADMINISTRATIVE SCIENCE.

SOPHOMORE YEAR.

FIRST SEMESTER.

(*a*) TRANSPORTATION GROUP. Same as in Civil Engineering.

(*b*) MANUFACTURING GROUP. Same as in Mechanical, Electrical, Mining, or Chemical Engineering.

SECOND SEMESTER.

(*a*) TRANSPORTATION GROUP. Civil Engineering schedule, modified by introduction of Elements of Economics.

(*b*) MANUFACTURING GROUP. Mechanical Engineering schedule, modified for those who have not taken Economics 1 E.

JUNIOR AND SENIOR YEARS.

(*a*) TRANSPORTATION GROUP. To follow Civil Engineering schedule, with Economics 6 E, Economic History of the United States; 3 E, Elements of Accounting, and other approved courses substituted for engineering courses.

(*b*) MANUFACTURING GROUP. To follow Mechanical Engineering schedule, with the same substitutions of courses in Economics as those indicated above.

The total of courses in Economics, History, and Sociology to be taken by students in Engineering and Administrative Science must amount to not less than 20 and not more than 26 hours.

CURRICULUM

Leading to the Degree of Bachelor of Science.

REQUIREMENTS FOR ADMISSION.

To be admitted to these courses of study the student must have completed all of the requirements for admission and thirty hours of work in the College. His work should have been selected so that at the close of the year in the College he will have completed, in entrance work and in College work combined, the following specified units (a unit is understood to mean one complete College entrance unit or five hours credit in the University):

4 units in Mathematics.
4 units in English.
4 units in Foreign Language.
1 unit in Physics or Chemistry.

If his work has not been selected to fulfill these requirements, the student will be required to make up all deficiencies.

WORK REQUIRED FOR GRADUATION.

The various courses of study outlined below are designed to give approximately the same amount of technical work as is given in the regular four-year period, but the preceding year spent in College work enables the student to obtain a wider general education and to have a little greater freedom in the selection of some of his scientific and engineering studies.

In the selection of his work in foreign language, the student is required to complete not less than five units of foreign language, of which at least two and three-fifths units must be in one modern language.

CIVIL ENGINEERING.

(BASED ON ONE YEAR OF COLLEGE WORK.)

FRESHMAN YEAR.

FIRST SEMESTER, 16 hours credit.

Course number.	*Subject.*	*Hours credit.*
Mathematics 4 E	Analytic Geometry	5
German, French or Spanish	(Course as approved)	5
Chemistry 2	Advanced Inorganic Chemistry	4
Engineering Drawing 1	Free-hand Drawing	2
Engineering Drawing 2	Mechanical Drawing	

SECOND SEMESTER, 17 hours credit.

Mathematics 5 E	Calculus I	5
German, French or Spanish	(Course as approved)	3
Chemistry 3	Qualitative Analysis	4
Engineering Drawing 3	Descriptive Geometry	3
Engineering Drawing 4	Machine Drawing	2

SOPHOMORE YEAR.

FIRST SEMESTER, 18½ hours credit.

Civil Engineering 1	Surveying	3
Mathematics 6 E	Calculus II	3
Physics 1 E	General Physics	5
Geology 1	Elementary Geology	5
Machine Construction 3 Machine Construction 4	Forging and Machine Shop Practice	2
	Technical Report I‡	½

SECOND SEMESTER, 18 hours credit.

Course number.	*Subject.*	*Hours credit.*
Civil Engineering 1 (continued)	Surveying	3
Civil Engineering 4	Railway Surveying	2
English 59	Advanced Composition	3
Physics 2 E	General Physics	5
Mechanical Engineering 5	Engines and Boilers	3
	Optional	2

SUMMER WORK.

Civil Engineering 3	Summer Field Work, 4 weeks.

JUNIOR YEAR.

FIRST SEMESTER, 17½ hours credit.

Civil Engineering 51	Cartography	2
Civil Engineering 55	Railway Surveying	4
Mechanics 50	Mechanics	5
Economics 1 E	Elements of Economics	3
	Optional	3
	Technical Report II‡	½

SECOND SEMESTER, 18½ hours credit.

Mechanics 53	Graphic Statics	3
Civil Engineering 57	Railway Location	3
Mechanics 51	Strength of Materials	4
Mechanics 52	Testing Laboratory	1
Mechanics 56	Hydraulic Laboratory	1
Mechanics 55	Hydraulics	3
	Optional	3
	Technical Report III‡	½

SUMMER WORK.

Civil Engineering 51	Summer Field Work, 4 weeks.

SENIOR YEAR.

FIRST SEMESTER, 17½ hours credit.

Civil Engineering 64	Masonry	2
Civil Engineering 65	Reinforced Concrete	3
Civil Engineering 61	Stresses in Framed Structures	5
Civil Engineering 70, or	Sanitary Engineering I	3
Electrical Engineering 60	Elements of Electrical Engineering	3
	Thesis‡	1
	Technical Report IV‡	½

SECOND SEMESTER, 16 hours credit.

Civil Engineering 62	Bridge Design	4
Engineering 52	Industrial Administration	3
Mechanics 57	Hydraulic Cement	1
Civil Engineering 75	Roads and Pavements	2
Civil Engineering 66	Reinforced Concrete Design	1
	Optional	3
	Thesis‡	2

One extended inspection trip is required during the Junior or the Senior year.

For Railway and Structural Engineering options, see page 15.

Municipal and Sanitary Option.

JUNIOR YEAR.

FIRST SEMESTER, 18½ hours credit.

Mechanics 50	Mechanics	5
Civil Engineering 73	Sanitary Science	2
Electrical Engineering 60	Elements of Electrical Engineering	3
Chemistry 56 E	Water Analysis	5
Economics 1 E	Elements of Economics	3
	Technical Report II‡	½

SECOND SEMESTER, 17½ hours credit.

Civil Engineering 75	Roads and Pavements	2
Civil Engineering 52	City Planning	2
Mechanics 55	Hydraulics	3
Mechanics 56	Hydraulic Laboratory	1
Civil Engineering 74	Waste and Garbage Disposal	1
Mechanics 51	Strength of Materials	4
Mechanics 52	Testing Laboratory	1
	Optional	3
	Technical Report III‡	½

SENIOR YEAR.

FIRST SEMESTER, 17½ hours credit.

Course number.	*Subject.*	*Hours credit.*
Civil Engineering 64	Masonry	2
Civil Engineering 65	Reinforced Concrete	3
Civil Engineering 61	Stresses in Framed Structures	4
Civil Engineering 70	Sanitary Engineering I	3
	Thesis‡	1
	Optional	4
	Technical Report IV‡	½

SECOND SEMESTER, 16 hours credit.

Course number.	*Subject.*	*Hours credit.*
Engineering 52	Industrial Administration	3
Civil Engineering 72	Sanitary Design	5
Civil Engineering 71	Sanitary Engineering II	4
Mechanics 57	Cement Laboratory	1
Civil Engineering 66	Reinforced Concrete Design	1
	Thesis†	2

One extended inspection trip is required during the Junior or the Senior year.

ELECTRICAL ENGINEERING.

(BASED ON ONE YEAR OF COLLEGE WORK.)

FRESHMAN YEAR.

FIRST SEMESTER, 18 hours credit.

Course number.	*Subject.*	*Hours credit.*
Mathematics 4 E	Analytic Geometry	5
Chemistry 2	Advanced Inorganic Chemistry	4
German, French or Spanish	(Course as approved)	5
Engineering Drawing 1 and Engineering Drawing 2	Free-hand Drawing Mechanical Drawing	2
Machine Construction 1 and Machine Construction 2	Foundry Practice Pattern Making	2

SECOND SEMESTER, 17 hours credit.

Course number.	*Subject.*	*Hours credit.*
Mathematics 5 E	Calculus I	5
Chemistry 3	Qualitative Analysis	4
German, French or Spanish	(Course as approved)	3
Engineering Drawing 3	Descriptive Geometry	3
Engineering Drawing 4	Machine Drawing	2

SOPHOMORE YEAR.

FIRST SEMESTER, 18½ hours credit.

Course number.	*Subject.*	*Hours credit.*
Physics 1 E	General Physics	5
Mathematics 6 E	Calculus II	3
Chemistry 64	Physical Chemistry I	5
Economics 1 E	Elements of Economics	3
Mechanical Engineering 1	Machine Drafting	1
Machine Construction 3	Forging	1
	Technical Report I‡	½

SECOND SEMESTER, 17½ hours credit.

Course number.	*Subject.*	*Hours credit.*
Mathematics	(Course to be elected)	3
Physics 2 E	General Physics	5
Mechanical Engineering 3	Elementary Machine Design	3
Mechanical Engineering 4	Steam Machinery	2
Civil Engineering 50	Surveying	3
Machine Construction 5	Bench Work	1
	Technical Report II‡	½

JUNIOR YEAR.

FIRST SEMESTER, 17½ hours credit.

Course number.	*Subject.*	*Hours credit.*
Electrical Engineering 50	Dynamo Machinery	3
Electrical Engineering 54	Electrical Laboratory	1½
Mechanics 50	Mechanics	5
Physics 52	Theory of Electricity	3
Physics 60 E	Electrical Measurements I	1½
Mechanical Engineering 52	Heat Engine Theory	3
	Technical Report III‡	½

SECOND SEMESTER, 18 hours credit.

Course number.	*Subject.*	*Hours credit.*
Electrical Engineering 51	Theory of Alternating Currents	5
Electrical Engineering 55	Electrical Laboratory	1½
Mechanical Engineering 53	Mechanics of the Steam Engine	2
Mechanics 51	Strength of Materials	4
Mechanics 52	Testing Laboratory	1
English 59	Advanced Composition	3
Physics 61 E	Electrical Measurements II	1½

SENIOR YEAR.

FIRST SEMESTER, 16 hours credit.

Course number.	*Subject.*	*Hours credit.*
Electrical Engineering 52	Advanced Dynamo Machinery	5
Electrical Engineering 56	Advanced Electrical Laboratory	1½
Mechanical Engineering 65	Power Laboratory	2
	Thesis‡	1
	Optional	6
	Technical Report IV‡	½

SECOND SEMESTER, 17 hours credit.

Electrical Engineering 57	Illuminating Engineering	3
Electrical Engineering 58	Electric Power Transmission	5
Engineering 52	Industrial Administration	3
	Optional	3
	Thesis‡	3

One extended inspection trip is required during the Junior or the Senior year.

MECHANICAL ENGINEERING.

(BASED ON ONE YEAR OF COLLEGE WORK.)

FRESHMAN YEAR.

FIRST SEMESTER, 17 hours credit.

Course number.	*Subject.*	*Hours credit.*
Mathematics 4 E	Analytic Geometry	5
Chemistry 2	Advanced Inorganic Chemistry	5
German, French or Spanish	(Course as approved)	5
Engineering Drawing 1	Free-hand Drawing	1⅓
Engineering Drawing 2	Mechanical Drawing	⅔

SECOND SEMESTER, 17 hours credit.

Mathematics 5 E	Calculus I	5
Chemistry 3 or 5 E	(Optional)	5 or 3
	(College Optional)	3 or 5
Engineering Drawing 4	Machine Drawing	2
Machine Construction 1 and Machine Construction 2	Foundry Practice Pattern Making	2

SOPHOMORE YEAR.

FIRST SEMESTER, 17½ hours credit.

Mathematics 6 E	Calculus II	3
Physics 1 E	General Physics	5
Engineering Drawing 3	Descriptive Geometry	3
Machine Construction 3 and Machine Construction 5 and Machine Construction 6	Forging Bench Work Machine Tool Work I	3
Mechanical Engineering 2	Mechanism	3
	Technical Report I‡	½

SECOND SEMESTER, 17½ hours credit.

Physics 2 E	General Physics	5
Mechanical Engineering 6	Steam Engineering	4
Mechanics 50	Mechanics	5
	Optional	3
	Technical Report II‡	½

JUNIOR YEAR.

FIRST SEMESTER, 17½ hours credit.

Mechanics 51	Strength of Materials	4
Mechanics 52	Testing Laboratory	1
Mechanical Engineering 51	Thermodynamics	4
Mechanical Engineering 64	Mechanical Laboratory	1
Metallurgy 61 E	Metallurgy I	3
Economics 1 E	Elements of Economics	3
Machine Construction 7	Machine Tool Work II	1
	Technical Report III‡	½

SECOND SEMESTER, 17 hours credit.

Mechanical Engineering 50	Machine Design	4
Mechanical Engineering 54	Heating, Ventilating, and Cooling	2
Mechanical Engineering 60	Shop Methods	2
English 59	Advanced Composition	3
Mechanical Engineering 66	Heat Engine Laboratory	2
Machine Construction 8	Machine Shop Practice	1
	Optional	3

SUMMER WORK.

Course number.	*Subject.*	*Hours credit.*
Mechanical Engineering 68	Summer Vacation Work.	

SENIOR YEAR.

FIRST SEMESTER, 18 hours credit.

Mechanical Engineering 56	Steam Engine and Turbine Design I	3
Mechanical Engineering 67	Thesis	1
Mechanics 55	Hydraulics	3
Mechanics 56	Hydraulic Laboratory	1
Engineering 51	Manufacturing	2
Electrical Engineering 50	Dynamo Machinery	3
Electrical Engineering 54	Electrical Laboratory	1½
Mechanical Engineering Option (see below)		3
	Technical Report	½

SECOND SEMESTER, 17½ hours credit.

Mechanical Engineering 67	Thesis	2
Civil Engineering 50	Surveying	3
Engineering 52	Industrial Administration	3
Electrical Engineering 53	Alternating Currents	3
Electrical Engineering 55	Electrical Laboratory	1½
Mechanical Engineering Option (see below)		5

Power Option.

FIRST SEMESTER.

Mechanical Engineering 58	Internal Combustion Motors I, or	3
Mechanics 58	Hydraulic Power	

SECOND SEMESTER.

Mechanical Engineering 57	Steam Engine and Turbine Design II, or	5
Mechanical Engineering 59	Internal Combustion Motors II, and	
	Other Engineering Option	

Manufactures Option.

FIRST SEMESTER.

Mechanical Engineering 55	Refrigeration, or	3
Mechanical Engineering 61	Structural Design	

SECOND SEMESTER.

Mechanical Engineering 58	Internal Combustion Motors, or	5
Mechanical Engineering 62	Industrial Plant Design, and	
	Other Engineering Option	

One extended inspection trip is required during the Junior or the Senior year.

MINING ENGINEERING.

(BASED ON ONE YEAR OF COLLEGE WORK.)

FRESHMAN YEAR.

FIRST SEMESTER, 17 hours credit.

Course number.	*Subject.*	*Hours credit.*
Chemistry 2	Advanced Inorganic Chemistry	5
Mathematics 4 E	Analytical Geometry and Theory of Equations	5
Engineering Drawing I	Free-hand Drawing	1⅓
Engineering Drawing II	Mechanical Drawing	⅔
Machine Construction 3	Forging	1
Machine Construction 5	Bench Work	1
Engineering 1	Engineering Lectures.	
	Optional	3

SECOND SEMESTER, 17 hours credit.

Mining Engineering 1	Mining Methods	1
Mathematics 5 E	Calculus I	5
Chemistry 3	Qualitative Analysis	5
Engineering Drawing 3	Descriptive Geometry	3
Engineering Drawing 4	Machine Drafting	2
Machine Construction 6	Machine Tool Work I	1

SOPHOMORE YEAR.

FIRST SEMESTER, 18½ hours credit.

Course number.	*Subject.*	*Hours credit.*
Geology I	Elementary Geology	5
Civil Engineering 1	Elementary Surveying	3
Physics 1 E	General Physics	5
Mechanical Engineering 4	Steam Machinery	2
Mechanical Engineering 1	Machine Drafting	1
	Optional	2
	Technical Report	½
	Mining Journal.	

SECOND SEMESTER, 18 hours credit.

Mining Engineering 51	(*a*) Excavation and Explosives (*b*) Practice Work	2
Mineralogy 10	Elementary Mineralogy	5
Civil Engineering 2	Higher Surveying	3
Physics 2 E	General Physics	5
English 59	Advanced Composition	3

JUNIOR YEAR.

FIRST SEMESTER, 17½ hours credit.

Mining Engineering 50	Mine Surveying	1
Geology 50	Historical Geology	3
Chemistry 54	Quantitative Analysis	5
Mechanics 50	Mechanics	5
Geology 54	Economic Geology I	3
	Technical Report II	½
	Mining Journal.	

SECOND SEMESTER, 18½ hours credit.

Mining Engineering 52	Mining Law	1
Metallurgy 64 E	Iron and Steel	2
Mechanics 51	Strength of Materials	4
Mechanics 52	Testing Laboratory	1
Metallurgy 57	Assaying	5
Geology 54	Economic Geology II	5
	Technical Report III	½
	Mining Journal.	

Metal Option.

SENIOR YEAR.

FIRST SEMESTER, 17½ hours credit.

Mining Engineering 53	Ore Dressing I	2
Mining Engineering 54	Metal Mining	2
Mining Engineering 56	Mine Plant and Mill Design I	2
Mining Engineering 55	Mining Hydraulics	2
Mining Engineering 68	Mineral and Public Land Surveying	2
Mining Engineering 64	Mining Engineering	2
Electrical Engineering 60	Electrical Engineering	3
	Technical Report IV	½
	Optional	2
	Mining Journal.	

SECOND SEMESTER, 16, 17 or 18 hours credit.

Mining Engineering 57	Mine Administration	1
Mining Engineering 58	Ore Dressing 2	4
Mining Engineering 59	Mine Examination and Reports	1
Mining Engineering 63, or	Mine Plant and Mill Designing II	3
Mining Engineering 67, or	Advanced Ore Dressing III	4
Mineralogy 61	Petrography	5
Metallurgy 62 E	Metallurgy	3
Engineering 52	Industrial Administration	2
Mining Engineering 60	Thesis	2

Coal Mining Option. (5-year Course.)

SENIOR YEAR.

FIRST SEMESTER, 18 hours credit.

Mining Engineering 53	Ore Dressing	2
Mining Engineering 61	Coal Mining I	2
Mining Engineering 56	Mill Plant and Mill Design I	2
Mining Engineering 55	Mining Hydraulics	2
Mining Engineering 68	Mineral and Public Land Surveying	2
Mining Engineering 64	Mining Engineering	2
	Optional	3
	Mining Journal.	

SECOND SEMESTER, 17 to 18 hours credit.

Course number.	*Subject.*	*Hours credit.*
Mining Engineering 57	Mine Administration	1
Mining Engineering 62	Coal Mining II	3
Mining Engineering 59	Mine Examination and Reports	1
Mining Engineering 63, or	Mine Plant and Mill Design II	3
Mining Engineering 67, or	Advanced Ore Dressing III	4
Mining Engineering 66	Mining Economy	2
Mining Engineering 52	Industrial Administration	2
Mining Engineering 60	Thesis	2
	Optional	3

CHEMICAL ENGINEERING.

(BASED ON ONE YEAR OF COLLEGE WORK.)

NOTE.—Students planning to take the four-year advanced course of study in chemical engineering are very strongly advised to elect chemistry 1 as part of their College work, in addition to the work already recommended in the statement preceding these advanced courses.

FRESHMAN YEAR.

FIRST SEMESTER, 17 hours credit.

Course number.	*Subject.*	*Hours credit.*
Chemistry 2	Advanced Inorganic Chemistry	5
Mathematics 4 E	Analytic Geometry and Theory of Equations	5
Engineering Drawing 1	Free-hand Drawing	2
Engineering Drawing 2	Mechanical Drawing	
	Optional	5

SECOND SEMESTER, 17 hours credit.

Chemistry 3	Qualitative Analysis	5
Mathematics 5 E	Calculus I	5
Engineering Drawing 3	Descriptive Geometry	3
Engineering Drawing 4	Machine Drawing	2
Machine Construction 1	Foundry Practice	2
Machine Construction 2	Pattern Making	

SOPHOMORE YEAR.

FIRST SEMESTER, 17½ hours credit.

Chemistry 54	Quantitative Analysis I	5
Physics 1 E	General Physics	5
Mechanics 50	Mechanics	5
Machine Construction 3 (modified)	Forging	1
Mechanical Engineering 1	Machine Drafting	1
	Technical Report I‡	½

SECOND SEMESTER, 18½ hours credit.

Chemistry 55	Quantitative Analysis II	5
Physics 2 E	General Physics	5
Mechanics 51	Strength of Materials	4
Mechanics 52	Testing Laboratory	1
Mechanical Engineering 3, or	Machine Design	3
Mechanical Engineering 5	Engines and Boilers	
	Technical Report II‡	½

JUNIOR YEAR.

FIRST SEMESTER, 18½ hours credit.

Chemistry 4	Organic Chemistry I	5
Metallurgy 61 E	Metallurgy I	3
Geology 1	Elementary Geology	5
English 59	Advanced Composition	3
Metallurgy 65 E	General Metallurgy	2
	Technical Report III†	½

SECOND SEMESTER, 18½ hours credit.

Chemistry 60	Organic Chemistry II	5
Chemistry 51 A	Inorganic Industrial Chemistry	3
Metallurgy 62 E	Metallurgy II	3
Mineralogy 10	Elementary Mineralogy I	5
	Optional	2
	Technical Report IV‡	½

SENIOR YEAR.

FIRST SEMESTER, 17 hours credit.

Course number.	*Subject.*	*Hours credit.*
Chemistry 51 B	Industrial Organic Chemistry	3
Chemistry 64	Physical Chemistry I	5
Chemistry	(Optional)	4
Economics 1 E	Elements of Economics	3
	Thesis‡	2

SECOND SEMESTER, 16 credit hours.

Chemistry 65	Physical Chemistry II	5
Metallurgy 57	Assaying	3
Engineering 52	Industrial Administration	3
	Optional	2
	Thesis‡	3

One extended inspection trip is required during the Senior year.

ARCHITECTURAL ENGINEERING.

(BASED ON ONE YEAR OF COLLEGE WORK.)

FRESHMAN YEAR.

FIRST SEMESTER, 18 hours credit.

Course number.	*Subject.*	*Hours credit.*
Architectural Engineering 1	Free-hand Drawing I	2
Mathematics 4 E	Analytic Geometry and Theory of Equations	5
German, French, or Spanish*	(Course as approved)	5
Chemistry 2	Advanced Inorganic Chemistry	4
Engineering Drawing 1 and 2	Mechanical Drawing	2

SECOND SEMESTER, 17 hours credit.

Architectural Engineering 2	Free-hand Drawing II	2
Mathematics 5 E	Calculus I	5
German, French, or Spanish	(Course as approved, or Optional)	3
Chemistry 3	Qualitative Analysis, or Optional	4
Engineering Drawing 3	Descriptive Geometry	3

SOPHOMORE YEAR.

FIRST SEMESTER, 18½ hours credit.

Architectural Engineering 3	Architectural Design I	3
Architectural Engineering 5	History of Architecture I	3
Architectural Engineering 7	Architectural Drawing I	1
Architectural Engineering 9	Shades and Shadows	1
Physics 1 E	General Physics	5
Mathematics 5 E	Calculus II	3
Machine Construction 1, and Machine Construction 2	Forging and Bench Work Woodworking and Molding	2
	Technical Report I‡	½

SECOND SEMESTER, 17½ hours credit.

Architectural Engineering 4	Architectural Design II	3
Architectural Engineering 6	History of Architecture II	3
Architectural Engineering 8	Architectural Drawing II	1
Physics 2 E	General Physics	5
Mechanical Engineering 4	Steam Machinery	2
	Optional	3
	Technical Report II‡	½

JUNIOR YEAR.

FIRST SEMESTER, 17½ hours credit.

Architectural Engineering 50	Architectural Design III	3
Architectural Engineering 56	History of Architecture III	2
Architectural Engineering 58	Building Construction I	3
Architectural Engineering 62	Architectural Drawing III	1
Mechanics 50	Mechanics	5
	Optional	3
	Technical Report III‡	½

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*French preferred.

SECOND SEMESTER, 17½ hours credit.

Course number.	*Subject.*	*Hours credit.*
Architectural Engineering 51	Architectural Design IV	3
Architectural Engineering 59	Building Construction II	3
Architectural Engineering 61	Building Sanitation	1
Architectural Engineering 63	Architectural Drawing IV	1
Mechanics 51	Strength of Materials	4
Mechanics 52	Testing Laboratory	1
Mechanics 53	Graphic Statics	2
Mechanical Engineering 54	Heating and Ventilation	2
	Technical Report IV‡	½

SENIOR YEAR.

FIRST SEMESTER, 19 hours credit.

Architectural Engineering 52	Architectural Design V	2
Civil Engineering 61	Stresses in Framed Structures	5
Civil Engineering 65	Reinforced Concrete	3
Economics 1 E	Elements of Economics	3
English 59	Advanced Composition	3
Electrical Engineering 64	Electrical Engineering for Architects	3

SECOND SEMESTER, 15 hours credit.

Architectural Engineering 53	Architectural Design VI	2
Architectural Engineering 57	Thesis	3
Architectural Engineering 65	Steel Construction	3
Mechanics 57	Hydraulic Cement	1
Engineering 52	Industrial Administration	3
Civil Engineering 52	Surveying	3

EQUIPMENT.

The School of Engineering is a part of the University; hence the entire equipment of the University is also equipment of the School of Engineering in all things in which engineering students are concerned. The work of the Engineering School which is common to several schools of the University, such as mathematics, physics, chemistry, languages, etc., is carried on to some extent in buildings and by departments of instruction not exclusively for engineering students; while such work of the School as is technical and exclusively engineering in character is carried on by departments of instruction primarily for engineering students and largely in buildings erected for the special work of the School. Below is described that part of the general equipment of the University which pertains chiefly to the work of this School. For other equipment, see "The College" and descriptions of other schools of the University.

BUILDINGS.

The buildings erected exclusively for engineering work are Marvin Hall, the mechanical laboratory in connection with the power plant, and the Fowler Shops. The work in mining is provided for in Haworth Hall. For description of these buildings, see the General Information section.

LIBRARIES.

The general University library is available for use of engineering students. The engineering library contains books, periodicals, pamphlets, maps, and manuscripts for use in the study of civil, mechanical, electrical, and architectural engineering. The departmental libraries in chemistry, geology, physics and astronomy, and mathematics are open to engineering students. Large plates and other illustrative material for the use of architecture students are in the reading room of the architectural engineering department.

DRAWING ROOMS.

Drawing rooms in Marvin Hall, furnished with individual tables containing drawers for each student's outfit, cabinets for drawing boards, etc., are provided for the work in general mechanical drawing, machine design, bridge and structural design, and architecture. Drawing rooms in Haworth Hall are similarly provided for the work in mining engineering.

On the walls and in print cases are photographs and drawings of actual construction and blue prints of working drawings for bridges, railroad structures, sewers, waterworks, mine plants, buildings, etc.

LABORATORIES.

Care has been taken to provide laboratory equipment of maximum effectiveness in the teaching of undergraduates. In certain of the laboratories, moreover, the means are at hand for carrying on more advanced research work.

For the work in pure science the laboratories of the College departments of physics, chemistry, and bacteriology are available. In this way engineering students are afforded all necessary opportunities for gaining familiarity with the most approved methods of carrying on work in the respective branches. Chemical-engineering students continue for a much longer time in the use of the apparatus provided in the department of chemistry than do the other students. Similarly, electrical-engineering students continue in the use of the finer types of electrical measuring instruments, which are provided in the well-equipped laboratories of the physics department. Mining-engineering students, and those following the civil-engineering option in sanitary and municipal work, draw largely also upon the pure-science laboratories, the former mainly in the lines of metallurgy and chemistry, the latter in the chemical and bacteriological examination of water and sewage.

In applied science the laboratories of the School of Engineering next come into use. Particular attention is paid to the work which is given to large numbers of engineering students irrespective of department groups. Among these are: the laboratory for the investigation of the strength of materials, which is provided with a special machine on which loads may be carried to a maximum of 200,000 pounds, and in which several smaller-capacity machines are employed for all student work; the laboratory for experimental work in hydraulics, which is equipped for the usual work in the measurement of flow of water over weirs, through pipes, and for measuring performance of pumps, water motors, etc.; the complete outfit of surveying instruments, by means of which the department of civil engineering carries on its work in connection with the teaching of surveying in all of its various refinements; the laboratory for the study of electrical machines of all kinds, and which is especially well equipped with respect to standardizing apparatus for the most accurate forms of electrical measuring instruments employed in engineering practice; the laboratory devoted to the study of electric-lighting problems, equipped with modern photometer and other apparatus adequate for the work; the laboratory for the study of steam- and gas-engine power development, equipped with many representative types of engines, boilers, and other lines of equipment necessary for an actual study of operating conditions; and the machine-construction laboratory, which is equipped with machines for the carrying on of all of the ordinary processes in shop work, but which is so employed that students may be considered to be studying methods employed in the production of machines rather than engaged in acquiring manipulative skill.

A third form of laboratory equipment is that applied to special problems in connection with the various lines of specialized work. Each of the departments is equipped in this way, all in very satisfactory measure with respect to undergraduate student work. The civil-engineering department is equipped to give special work for those engaged in the advanced branches of railway surveying, and for the investigation of road-making materials. It owns a complete outfit for its work carried on during the summer surveying-camp period. The department of mechanics is equipped to carry on special investigations in reinforced concrete, and with various other forms of material employed in engineering structures. The electrical-engineering department is provided with necessary equipment for carrying on research work with alternating-current machinery, in telephony, and with electrical measuring instruments. The mechanical-engineering department, in connection with the University power plant, is able to carry on many lines of investigation in steam-power generation, with gas engines, with refrigerating apparatus, and in the study of fuels and lubricating oils. With the proper equipment, and in coöperation with the department of metallurgy, students are enabled to make special studies of tool steels, and the effects of heat upon metals of various kinds. The mining engineering laboratories are equipped for large-scale tests on various ores, for washing coal in ten-ton lots, for the study of fuels and of coal-mine explosions. Students are given mine-surveying practice in the State Mine at Lansing and in the tunnels of the University heating system, and practice in tunneling and the use of explosives in the experimental mine on the campus.

In the lines of applied chemistry the equipment is of high grade and well adapted to the carrying on of work characteristic of the chemical industries as well as for the study of special metals and the analytical work on ores and the many other forms of material with which the industrial chemist must deal. In the rooms of the architectural-engineering department are deposited the many illustrative drawings, plates, and lantern slides which are of service in the study of architectural forms and in creative designing work, which fills so important a position in the training of the architect.

DESCRIPTION OF COURSES.

ARCHITECTURAL ENGINEERING.

Professor GOLDSMITH.
Professor GRIFFITH.
Professor RICE (H. A.).
Mr. WHITTEN, Assistant Instructor.

1.—FREE-HAND DRAWING I. Two hours credit. First semester, M. W. F., 8:30 to 10:30. Charcoal and pencil drawing from the cast. Griffith.

2.—FREE-HAND DRAWING II. Two hours credit. Second semester, six hours. Theory of perspective, free-hand perspective, shades and shadows. Griffith.

3.—ARCHITECTURAL DESIGN I. Three hours credit. First semester, nine hours. A study of the elementary architectural forms and fundamental construction features, their employment in architectural composition, the classic orders. Drafting-room work and informal lectures. Goldsmith and Whitten.

4.—ARCHITECTURAL DESIGN II. Three hours credit. Second semester, nine hours. Continuation of course 3, the application of the orders in elementary design. A study and analysis of architectural composition based on the orders, designed to train the student in the æsthetics of architecture and the fundamentals of design. Drafting-room work and informal lectures. Goldsmith and Whitten.

5.—HISTORY OF ARCHITECTURE I. Three hours credit. First semester, three hours, M. W. F., at 8:30. An analytical study of architectural development of the historic styles, explaining the underlying principles of construction and design, influence of materials, and effects of religious and political conditions. The first semester will include the architecture of Egypt, Assyria, Persia, Greece, and Rome. Illustrated lectures, reading, and sketching. Goldsmith.

6.—HISTORY OF ARCHITECTURE II. Three hours credit. Second semester, three hours, M. W. F., at 10:30. Continuation of course 5, from the close of Roman supremacy through the periods of Byzantine, Romanesque and Gothic development, and the Renaissance. Illustrated lectures, reading, sketching, and research. Goldsmith.

7.—ARCHITECTURAL DRAWING I. One hour credit. First semester, three hours. Pencil drawing from casts of architectural ornament and historic details, designed to prepare the student for the free use of sketching in architectural composition and design. Goldsmith.

8.—ARCHITECTURAL DRAWING II. One hour credit. Second semester, three hours. Continuation of course 7. Pen, pencil, and brush work. Goldsmith.

9.—SHADES AND SHADOWS. One hour credit. First semester, three hours. Application of the principles of descriptive geometry in casting conventional shadows. Conventional rendering of architectural subjects. Goldsmith and Whitten.

50.—ARCHITECTURAL DESIGN III. Three hours credit. First semester, nine hours. Continuation of course 4. Problems in theoretical design, alternating with problems in constructive design, working drawings and details, applying the knowledge gained in course 58. Goldsmith.

51.—ARCHITECTURAL DESIGN IV. Three hours credit. Second semester, nine hours. Continuation of course 50. Problems in design of increased importance, alternating with problems in constructive design based on course 59. Goldsmith.

52.—ARCHITECTURAL DESIGN V. Two hours credit. First semester, six hours. A course of engineering design combining problems in engineering with architectural composition and applying the technical knowledge gained in the engineering courses. Goldsmith.

53.—ARCHITECTURAL DESIGN VI. Two hours credit. Second semester, six hours. Continuation of course 52. Goldsmith.

56.—HISTORY OF ARCHITECTURE III. Two hours credit. First semester, two hours. Continuation of course 6, including the classic and Gothic revivals and modern architecture in Europe and the United States. Illustrated lectures, reading, sketching, and research. Goldsmith.

57.—THESIS. Two hours credit. Second semester, six hours. An extended problem in architectural-engineering design requiring complete plans, elevations, section and construction details, with outline specifications of building materials and methods. The subject may be chosen by the student with the approval of the professor of architecture. Goldsmith.

58.—BUILDING CONSTRUCTION I. Three hours credit. First semester, three hours, M. W. F., at 9:30. A study of the principles of wooden construction and their application in structural design, working drawings, and details. This course considers building and finishing woods, framing of wooden buildings, details of exterior finish, interior woodwork, and cabinet work. Lectures, reading, and drafting-room work. Goldsmith.

59.—BUILDING CONSTRUCTION II. Three hours credit. Second semester, three hours, M. W. F., at 9:30. A study of the principles of masonry construction and their application. This course considers building stones, brickwork, terra cotta, simple cast-iron and steel work, fireproofing, and pastering. Lectures, reading, and drafting-room work. Goldsmith.

61.—BUILDING SANITATION. One hour credit. Second semester. Plumbing, sewerage, water-supply, and plumbing fixtures. Lectures, reading, and drafting-room work. Goldsmith and Whitten.

62.—ARCHITECTURAL DRAWING III. One hour credit. First semester, three hours. Continuation of course 8. Goldsmith.

63.—ARCHITECTURAL DRAWING IV. One hour credit. Second semester, three hours. Continuation of course 62. Goldsmith.

65.—STEEL CONSTRUCTION. Three hours credit. Second semester. A course in steel framing of buildings. Drafting-room work. H. A. Rice.

BACTERIOLOGY.

Assistant Professor C. C. YOUNG.

53E.—SANITARY WATER ANALYSIS. Five hours credit. First semester, daily, 8:30 to 10:30. (See chemistry 56E.) Part of the semester will be devoted to bacteriological technic and reading along general lines, followed by special work on the bacteriology of water and sewage. The remainder of the semester will be spent in chemical quantitative analysis of water and sewage and interpretation of results of sanitary tests. Open to students in engineering and to College Juniors and Seniors who have taken chemistry 3. C. C. Young.

For other courses in bacteriology, see The College.

CHEMISTRY.

Professor CADY.
Professor DAINS.
Associate Professor WHITAKER.
Associate Professor ALLEN.
Assistant Professor YOUNG (C. C.).
Assistant Professor BRUCKMILLER.
Assistant Professor FARAGHER.
Mr. WHELAN, Instructor.
Mr. LICHTENWALTER, Instructor.
Mr. PARKHURST, Instructor.

2.—ADVANCED INORGANIC CHEMISTRY. Four or five hours credit. First semester. Recitations, M. W. F., at 8:30; laboratory, Tu. Th., 8:30 to 10:30, or 1:30 to 3:30. Chemical and mining-engineering students take four hours laboratory, others two hours. Cady, Faragher, and assistants.

3.—QUALITATIVE ANALYSIS. Four or five hours credit. Second semester. Recitations, Tu. Th., at 8:30; laboratory, M. W. F., 8:30 to 10:30, or 1:30

to 3:30. Chemical-engineering students take six hours laboratory, others four hours. Cady, Faragher, and assistants.

4.—ORGANIC CHEMISTRY I. Five hours credit. Junior, first semester, seven hours. Lectures and recitations, M. W. F., at 9:30; laboratory, Tu. Th., 1:30 to 3:30. Required of chemical-engineering students. Lectures, recitations, and laboratory work in aliphatic series. Must be preceded by courses 2 and 3. Dains.

5E.—ENGINEERING CHEMISTRY. Three hours credit. Second semester. Recitations, Tu. Th., at 9:30; laboratory, F., 1:30 to 4:30. Required of mechanical- and civil-engineering students. Cady and assistants.

50E.—GAS ANALYSIS. Two hours credit. Optional, first semester, four hours, by appointment. A laboratory course in the quantitative determination of the common gases, analysis of gaseous mixtures, natural gas, flue gas, etc. Must be preceded by course 54. Allen.

51A.—INORGANIC INDUSTRIAL CHEMISTRY. Three hours credit. Second semester, at 11:30. Required of Junior chemical-engineering students. A study of the inorganic industries, including such topics as the manufacture of acids, alkalies and other chemicals, fertilizers, paints and pigments, glass and cement, and the purification of water. Prerequisites, courses 2 and 3. Whitaker and Parkhurst.

51B.—ORGANIC INDUSTRIAL CHEMISTRY. Three hours credit. First semester, at 9:30. Required of Senior chemical-engineering students. A study of the organic industries, including such topics as the refining of petroleum, the distillation of wood and coal, packing houses, fermentation, soaps, leather, paper, starches, sugars, dye-stuffs, etc. Prerequisites, courses 2, 3, 4. Whitaker and Parkhurst.

52E.—ELECTROLYTIC ESTIMATION OF METALS. Two hours credit. Optional. Second semester, four hours, by appointment. A laboratory course. Must be preceded by course 54.

53E.—ANALYSIS OF BOILER FEED WATER. Two hours credit. Optional. First semester, four hours, by appointment. Must be preceded by course 54. C. C. Young.

54.—QUANTITATIVE ANALYSIS I. Five hours credit. Both semesters. First semester, ten hours, 10:30 to 12:30, or 3:30 to 5:30; second semester, ten hours, 10:30 to 12:30. Lecture and laboratory work. Must be preceded by course 3. Required of chemical- and mining-engineering students. Allen and assistants.

55.—QUANTITATIVE ANALYSIS II. Five hours credit. Second semester, ten hours, 1:30 to 3:30. Lecture and laboratory work. Required of chemical-engineering students. In the latter part of the course the volumetric analysis of ores and metallurgical products will be taken up. Allen and assistants.

56E.—SANITARY WATER ANALYSIS. Five hours credit. First semester, 8:30 to 10:30. (See bacteriology 53E.) Open to students in engineering and to College Juniors and Seniors who have taken chemistry 3. Part of the semester will be devoted to bacteriological technic and reading along general lines, followed by special work on the bacteriology of water and sewage. The remainder of the semester will be spent in chemical quantitative analysis of water and sewage and interpretation of results of sanitary tests. C. C. Young and Bruckmiller.

59.—WATER ANALYSIS. Three hours. Second semester, by appointment. Laboratory work and conferences upon assigned readings. The course covers sanitary, mineral, and boiler-feed-water analysis, together with the principles and practice of the purification of water for municipal and other uses. Prerequisite, course 54. C. C. Young.

60.—ORGANIC CHEMISTRY II. Five hours credit. Junior, second semester, seven hours, M. W. F., at 9:30; laboratory, Tu. Th. afternoons, by appointment. A continuation of course 4. Lectures, recitations, and laboratory work, including the aromatic and other cyclic compounds. Must be preceded by course 4. Required of chemical-engineering students. Dains.

64.—PHYSICAL CHEMISTRY I. Five hours credit. First semester, six hours, at 10:30. A course paying special attention to electrochemistry.

Lectures and laboratory work. Must be preceded by course 54, or by course 3 and physics 1E and 2E and mathematics 5E. Required of chemical- and electrical-engineering students; optional for mining engineers. Cady.

65.—PHYSICAL CHEMISTRY II. Five hours credit. Second semester, seven hours, at 10:30. A general course in theoretical and physical chemistry. Lectures and laboratory work. Required of chemical-engineering students. Cady.

Other courses in chemistry are open as optionals to chemical-engineering students. See The College.

CIVIL ENGINEERING.

Professor DALTON.*
Professor RICE (H. A.).
Professor WILLIAMS.
Associate Professor HASKINS.
Associate Professor McNOWN.
Assistant Professor BROWN (F. L.).
Assistant Professor ROBERTS.

1.—ELEMENTARY SURVEYING. Three hours credit. First semester, two hours of class work, Tu. Th., at 10:30 and 11:30; one hour of field work, computation and plotting, on Tu. or Th., from 1:30 to 4:30. Required of civil- and mining-engineering Sophomores. Use and care of engineer's chain, transit and level. Adjustments of transit and level. Land surveying methods and computations. Prerequisite, mathematics 3. McNown.

2.—HIGHER SURVEYING. Three credits. Second semester, Tu. Th., at 9:30 and 10:30, with field work W. or F., at 1:30 to 4:30. Required of civil- and mining-engineering Sophomores. Topographic and hydrographic surveying. Control of surveys, including introduction to engineering astronomy. Prerequisite, civil engineering 1. McNown.

3.—SUMMER FIELD WORK. Ten hours a day for four weeks at the close of the college year is required of Sophomore civil-engineering students, and the same for two weeks is required of Sophomore mining-engineering students. A topographical survey of an area is made from a camp. Practice in taking topography by transit and stadia, and by plane table, measurement of a base line, triangulation, leveling, and determination of azimuth latitude and time, constitutes the work. Prerequisite, civil engineering 2. McNown and F. L. Brown.

4.—RAILWAY SURVEYING. Two hours credit. Second semester, Tu. Th., at 1:30. Required of civil-engineering Sophomores. A study of railway curves and earthwork, with field exercises. Prerequisite, civil engineering 1. McNown.

50.—ELEMENTARY SURVEYING. Three hours credit. Both semesters. Two hours of class work, Tu. Th., at 9:30 in the first and at 8:30 in the second semester. One hour of field from 1:30 to 4:30, on Friday in the first and on Monday in the second semester. Required of Senior mechanical, electrical, and architectural students. A brief course based on courses 1 and 2. McNown and Roberts.

51.—CARTOGRAPHY. Two hours credit. First semester, Tu. Th., from 1:30 to 4:30. Required of Junior civil-engineering students. Map projection and the preparation of an accurate topographical map based on the field maps prepared in civil engineering 3. Prerequisite, civil engineering 3. McNown.

52.—CITY PLANNING. Two hours credit. Second semester, W. F., at 8:30. Required of Junior sanitary students, and optional to Senior civil-engineering students. A study of city planning from the modern viewpoint, under such topics as city planning abroad, the American city, design of streets and street systems, parks and playgrounds, civic centers, water features, methods of acquiring land, and legislation. Lectures and assigned readings. McNown.

53.—GEODESY. Three hours credit. First semester. Two hours in classroom and one in field, and computation. By appointment. Optional to

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*On leave of absence.

Seniors. A brief study of the construction, use, and adjustment of the higher instruments of precision, and their use in the determination of the size and figure of the earth, including a study of the application of the method of least squares to the adjustment of observations. Prerequisite, civil engineering 3. McNown.

55.—Railway Surveying. Four hours credit. First semester, Junior year, Tu. Th., at 9:30, M. W., at 1:30. A study of methods of laying out and constructing railways, with field practice consisting of a location survey of a line of sufficient length to familiarize the student with standard methods of doing such work; calculation of waterways; bridge surveys; yards, turnouts, and easement curves. Prerequisites, civil engineering 1, 2, 3, and 4. Williams.

57.—Railway Location. Three hours credit. Second semester, Junior year, M. W. F., at 11:30. The principles involved in the economic location and construction of railways. Analysis of traffic and operating expenses. The influence of proposed changes in location upon the amount of total revenue, the fixed charges, the operating expense, and the dividend-paying capacity of the road. Prerequisite, civil engineering 55. Williams.

58.—Railway Terminals and Signaling. Two hours credit. First semester, Senior year, Tu. Th., at 8:30. A general study of terminal problems, the design of yard layouts and of terminal structures. Some time given to signal engineering. Prerequisite, civil engineering 55. Williams.

59.—Railway Construction and Maintenance. Three hours credit. Second semester, Senior year, M. W. F., at 10:30. An advanced course in railway engineering, covering tunneling, economic handling of materials, masonry structures, trestles, timber preservation, as well as the theory and practice of railway maintenance. Prerequisite, civil engineering 55. Williams.

61.—Stresses in Framed Structures. Five hours credit. First semester, five hours, at 11:30.. Analytical and graphical calculation of stresses in framed structures under various forms of loading. This course must be preceded by course 51 in mechanics. H. A. Rice.

62.—Bridge Designing. Four hours credit. Second semester, eight hours, 1:30 to 4:30. A study in bridge details and the dimensions of parts. Students work out designs for a plate girder and a simple truss. Must be preceded by course 61. H. A. Rice.

64.—Masonry. Two hours credit. First semester, Senior year, Tu. Th., at 10:30. Stone and brick masonry; the science of proportioning concrete; foundations, including pile driving, cofferdams, pneumatic caissons, etc.; dams, retaining walls, piers and abutments, masonry bridges. Prerequisite, mechanics 50 and 51. Williams.

65.—Reinforced Concrete. Three hours credit. Senior, first semester, M. W. F., at 10:30. A course in the modern theory and practice in the design of beams, floor slabs, columns, conduits, retaining walls, arches, and other forms of reinforced concrete construction. Mathematical theory, study of plans, and design of typical structures. Prerequisite, mechanics 51. H. A. Rice.

66.—Reinforced Concrete Design. One hour credit. Second semester, Senior. This course supplements course 65. Designs of beams, slabs, retaining walls, etc., together with a complete analysis of a reinforced-concrete arch, are made. Prerequisite, civil engineering 65. H. A. Rice.

67.—Higher Structures. Three hours credit. Second semester, Senior, M. W. F., at 9:30. An advanced course in bridges, including swing bridges, cantilever bridges, suspension bridges and arches. Some work will be given in calculations of deflections and statically indeterminate stresses. H. A. Rice.

70.—Sanitary Engineering I. Three hours credit. First semester, three hours, M. W. F., at 11:30. An elementary course in the collection, removal and disposal of city sewage. Principles of the design and construction of sewers and storm drains. The collection and distribution of water supplies. Requisites of a supply as to quality and quantity. Design of distribution, collection, and storage works. Prerequisite, mechanics 55. Haskins.

71.—SANITARY ENGINEERING II. Fours hours credit. Second semester, four hours, M. Tu. W. Th., at 9:30. A more detailed study of the subjects treated in course 59. The purification of public water supplies and the treatment of sewage. Haskins.

72.—SANITARY ENGINEERING DESIGN. Five hours credit. Second semester, five hours, at 1:30. An advanced course to be taken simultaneously with course 71. The student works out, by practical problems, the principles learned in courses 70 and 71. Haskins.

73.—SANITARY SCIENCE AND PUBLIC HEALTH PROBLEMS. Two hours credit. First semester, two hours, Tu. Th., at 9:30. A broad general view of the large body of sanitary science upon which the modern practice of sanitation is based. The effects of good practice in such matters as public water supply, sewerage and drainage, state and federal control over the pollution of streams, vital statistics. Haskins.

74.—WASTE AND GARBAGE DISPOSAL. One hour credit. Second semester, one hour, M., at 11:30. A lecture course in the practice of street cleaning, refuse and garbage collection and disposal. Haskins.

75.—ROADS AND PAVEMENTS. Two hours credit. Second semester, Senior year, Tu. Th., at 11:30. A study of methods used in the construction and improvement of country roads and city streets. An extended study of paving materials and of the principles governing the selection of a pavement. Some time given to laboratory testing of materials. Prerequisite, civil engineering 1, 2, 3, and 4. Williams.

ECONOMICS.

Professor MILLIS.
Associate Professor BOYNTON.
Assistant Professor HODGES.

1E.—ELEMENTS OF ECONOMICS. Three hours credit. First semester, M. W. F., at 11:30. This course endeavors to explain the general laws of man's relation to wealth. Special attention is given to the parts of the subject of special interest to engineering students, such as corporations, the economic activities of municipalities, organized labor, and the general labor problem. Millis.

3.—ECONOMIC HISTORY OF THE UNITED STATES. Three hours credit. Second semester, at 9:30. Attention is given to colonial agriculture, industry, and trade as an introduction to the course. After 1789, the main lines of study are the banking, transportation, and tariff history of the United States, with especial attention to the development of the natural resources, and the rise of manufactures, and the expansion of corporate methods. Prerequisite, course 1. Boynton.

3E.—THE ELEMENTS OF ACCOUNTING. Three hours credit. First semester, M. W. F. This course serves as an introduction to the field of accounting. The principles underlying various accounting practices are studied, and enough problems are solved to familiarize the student with the more common and simpler forms used in representing the progress and condition of a business firm. Prerequisite, course 1E or its equivalent. Hodges.

ELECTRICAL ENGINEERING.

Professor SHAAD.
Associate Professor JOHNSON (C. A.).
Mr. JOHNSON (F. E.), Instructor.
Mr. CURFMAN, Instructor.

Courses 50 to 52, and 54 to 58, inclusive, and 61 are required of all electrical-engineering students. Courses 50, 53, 54, and 55 are required of mechanical-engineering students. Courses 59 and 62 are optional for electrical-engineering students.

50.—DYNAMO MACHINERY. Three hours credit. Junior, first semester, three hours, at 10:30 for electrical-engineering students, and at 8:30 for

Senior mechanical-engineering students. Theory of direct-current generators and motors. Prerequisites, physics 1E and 2E. C. A. Johnson.

51.—THEORY OF ALTERNATING CURRENTS. Five hours credit. Junior, second semester, five hours, at 8:30, for electrical-engineering students. A mathematical treatment of alternating-current phenomena and the theory of alternating-current machinery, fundamental types. Prerequisite, course 50. Shaad.

52.—DYNAMO MACHINERY. Five hours credit. Senior, first semester, five hours, at 8:30. Advanced theory of alternating-current machinery. Shaad.

53.—THEORY OF ALTERNATING CURRENTS. Three hours credit. Second semester, three hours, M. W. F., at 11:30 for Senior mechanical-engineering students. A study of the theory of alternating currents and alternating-current machinery, together with a discussion of motor applications. Prerequisite, course 50. Shaad.

54.—ELECTRICAL LABORATORY. One and one-half hours credit. Junior, first semester, three hours, two days per week on alternate weeks, 1:30 to 4:30. An experimental course for the purpose of illustrating the principles of direct-current dynamo machinery and acquainting the student with the types and performance of direct-current apparatus. Must be preceded or accompanied by course 50. F. E. Johnson and Curfman.

55.—ELECTRICAL LABORATORY. One and one-half hours credit. Junior, second semester, three hours, two days per week on alternate weeks, 1:30 to 4:30. A continuation of course 54. Must be preceded or accompanied by course 51. More advanced work with direct-current machinery is given and experiments with alternating-current apparatus are introduced. Some time is devoted to the calibration of electrical instruments. F. E. Johnson and Curfman.

56.—ELECTRICAL LABORATORY. One and one-half hours credit. Senior, first semester, three hours, two days per week, 1:30 to 4:30. Advanced experiments with electrical machinery and the testing of machines, chiefly of alternating-current types. Must be accompanied by course 52. C. A. Johnson and F. E. Johnson.

57.—ILLUMINATING ENGINEERING. Three hours credit. Senior, second semester, three hours, Tu. Th., at 11:30. A course in illumination and photometry, in which the available light sources are studied and the methods of application to artificial illumination of streets and buildings are discussed. Laboratory and field work in the measurement of light sources and illumination. C. A. Johnson.

58.—ELECTRIC POWER TRANSMISSION AND ELECTRIC RAILWAYS. Five hours credit. Senior, second semester, five hours, at 9:30. A series of lectures and recitations devoted to the study of the principles involved and the methods used in the design of transmission and distributing systems and the theory and practice of the design, construction, and operation of electric railway systems. Prerequisite, course 52. C. A. Johnson.

59.—ELEMENTARY TELEPHONY. Five hours credit. Second semester, five hours by appointment. Lectures, recitations, and laboratory work. The principles that underlie all telephone apparatus, and practical experiments with the fundamental telephone transmitters, receivers, and central-station arrangements. Optional for Juniors or Seniors. Shaad.

60.—ELEMENTS OF ELECTRICAL ENGINEERING. Three hours credit. First semester, at 9:30. A course covering the general field of electrical engineering, and prepared especially for civil-engineering students. Junior or Senior year. Shaad.

61.—PROFESSIONAL THESIS. Senior, first semester, three hours, and second semester, nine hours, by appointment. Shaad, or other instructors, according to the line of work chosen.

62.—CENTRAL STATIONS. Three hours credit. Three hours in the classroom, M. W. F., at 10:30, and one period in the drafting room each week. A study of the design, construction, operation, and management of central electrical stations and substations. Shaad.

63.—ADVANCED ELECTRICAL LABORATORY. Five hours credit. Seniors, second semester, by appointment. A continuation of course 56. More advanced and extended experiments with electrical machinery and circuits, introducing the experimental study of transient electrical phenomena. C. A. Johnson.

64.—ELECTRICAL ENGINEERING FOR ARCHITECTS. Three hours credit. First semester, three hours, at 9:30. A course covering electrical installations for buildings. For students in architectural engineering, either Junior or Senior year. Shaad.

ENGINEERING.

Dean WALKER.

1.—ENGINEERING LECTURES. First semester, Tu., at 11:30. A course of lectures given to Freshmen during the first semester. The purpose is twofold: first, to give the student a more adequate idea of engineering as a profession; second, to assist those who have not decided upon the courses of study to be pursued to gain a more definite conception of the field covered in each. About one-third of the course is given by the Dean and the remainder by other members of the engineering faculty.

51.—MANUFACTURING. Two hours credit. First semester, Senior, Tu. Th., at 8:30. Manufacturing processes employed in certain typical industries; elements of cost; power as a factor in costs; power applications; engineering practice in the industries with especial reference to selection of equipment. Walker.

52.—INDUSTRIAL ADMINISTRATION. Three hours credit. Second semester, at 8:30. Development of modern industrial systems; forms of ownership—partnerships and corporations; contract principles, and practice in contract writing for engineering work; organization of transportation and manufacturing companies; analysis of costs; labor wage systems. Special lectures on real property, agency and torts. Mining engineering students are allowed to take a portion of the course for two hours credit. Walker and law lecturers.

ENGINEERING DRAWING.

Associate Professor HOOD.
Assistant Professor COCHRAN.
Assistant Professor ROBERTS.

1.—FREE-HAND DRAWING. One and one-third hours credit. Freshman, first twelve or six weeks of both semesters; six hours or twelve hours; first semester, M. W. F., 8:30 to 10:30; or M. W. F. Sat., 8:30 to 11:30; or M. Tu. W. Th., 1:30 to 4:30; or F., 1:30 to 4:30, and Sat., 8:30 to 11:30. Second semester, M. W. F., 8:30 to 10:30; or M. W., 1:30 to 4:30. Engineering lettering in pencil and in ink. Free-hand working sketches and perspective sketches of simple machine parts. Hood, Cochran, and Roberts.

2.—ELEMENTARY MECHANICAL DRAWING. Two-thirds hour credit. Freshman, six or three weeks of both semesters; six hours or twelve hours. Same hours as in course 1. Working drawings of simple machine parts. Penciling, tracing, and blue-printing. Detailing machine parts from assembly drawings. Hood, Cochran, and Roberts.

3.—DESCRIPTIVE GEOMETRY. Three hours credit. Freshman, second semester, three hours, M. W. F., at 8:30, 9:30, 10:30, 11:30, and 3:30; also first semester, at 11:30. Principles of projection. Execution of a large number of original exercises. Hood and Cochran.

4.—MACHINE DRAWING. Two hours credit. Freshman, eighteen weeks or nine weeks of both semesters; six hours or twelve hours. Same hours as in course 1. Sketches of machine parts and preparation of working drawings; detailing of machines from sketches, notes, assembly drawings and assembled machines; tracing and blue-printing; notes and lectures on drafting-room methods. Each student prepares complete drawings for some simple machine. Hood, Cochran, and Roberts.

ENGLISH LANGUAGE AND LITERATURE.

Associate Professor RAYMOND.
Mr. MCCARTY, Instructor.
Miss LAIRD, Instructor.

The instruction in this department, while in essentials parallel to that in the College, is shaped with special reference to the other work of engineering students. Three of the courses here numbered are required before graduation; for students who wish to spend more time in work of this kind a research class is provided in the Graduate School, and appropriate classes in the College are open.

1E.—RHETORIC I. Three hours credit. First semester, three hours, 8:30, 9:30, 10:30, 11:30, 2:30; second semester, at 11:30. Written exercises and papers, with study of language usage. Required of all Freshmen. McCarty, Laird, and Raymond.

2E.—RHETORIC II. Two hours credit. Second semester, two hours, 8:30, 9:30, 10:30, 11:30, 3:30. Continuation of course 1E. McCarty, Laird, and Raymond.

59.—ADVANCED COMPOSITION I. Three hours credit. First semester at 10:30 and 11:30; second semester, at 8:30 and 9:30. Practice in the gathering and analyzing of material, and in the presentation of information and opinion in scientific papers, and study of the methods used in these and other papers. Required of all engineering students, one semester in Junior or Senior year. Raymond.

59*b*.—ADVANCED COMPOSITION II. Three hours credit. Continuation of course 59, with special regard to writing for publication. Optional for Seniors. Raymond.

For other work related to that of the English department see the courses in engineering, and under The College.

The department of English is provided with references, illustrative matter, and other helps for reading in general and in engineering literature, and in the preparation of special papers.

GEOLOGY.

Professor HAWORTH.
Associate Professor TWENHOFEL.
Assistant Professor TODD.

1.—ELEMENTARY GEOLOGY. Five hours credit. First semester, 8:30, 9:30; second semester, 8:30, 9:30, 10:30, 11:30, 2:30. A study of the elementary principles of geology, including a general outline of geologic principles and geologic agencies. An acquaintance with the elements of chemistry, zoölogy, and botany will be of advantage in this course. Required of Junior civil and Sophomore mining engineering students. Todd and Twenhofel.

54.—ECONOMIC GEOLOGY I. Three hours credit. First semester, three hours, M. W. F., at 9:30. A general study of the metallic and nonmetallic products of the mine and quarry, considered from a scientific and practical standpoint, including the nature, origin, amount, and geographic and geologic distribution of the same. Must be preceded by elementary chemistry and course 1, and mineralogy 10. Required of Junior mining-engineering students. Lectures and library work. Haworth.

55.—ECONOMIC GEOLOGY II. Two hours credit. Second semester, two hours, Tu. Th., at 10:30. A continuation of course 54. Nonmetallic products. Haworth.

Other courses in geology are open as optionals to engineering students. For details, see the courses listed under The College.

GERMAN.

Assistant Professor BRIGGS.
Mr. HAWKINS, Instructor.

1.—OUTLINE OF GRAMMAR. Five hours credit. First semester, five hours, at 10:30. The first twenty-two lessons of the Otis-Carruth Grammar, with composition exercises; Carruth's Reader, about fifty pages. Hawkins.

2.—GRAMMAR, READER, AND "TELL." Five hours credit. First semester, five hours, at 1:30; second semester, five hours, at 10:30. The last eight lessons of Carruth's Grammar; Carruth's Reader completed. Schiller's Wilhelm Tell. Hawkins.

3.—PROSE CLASSICS. Five hours credit. First semester, five hours, at 8:30; second semester, five hours, at 1:30. Lessing's Minna von Barnhelm; extracts from Schiller's Der dreiszigjährige Krieg, preceded by a review of grammar. Briggs.

4.—(Students wishing German 4 either semester will be accommodated in suitable sections in the College.) Five hours. Five credits.

6.—SCIENTIFIC PROSE. Three hours credit. Either semester, three hours, at 9:30. Lassar-Cohn's Die Chemie im täglichen Leben, Scientific Reader, and a general survey of German scientific literature. Intended to promote rapid, intelligent reading of scientific German. Briggs.

MACHINE CONSTRUCTION.

Assistant Professor JONES (F. E.).
Mr. WILTFONG, Instructor.
Mr. ROCKLUND, Instructor.
Mr. WHITE, Instructor.

The work given is designed to suit the needs of engineering students. It consists of practice work following demonstrations and recitations in the classroom. Textbook preparation and note writing are required in the class work. One hour of each regularly assigned weekly period is devoted to classroom work during a portion of the semester. In the advanced courses attention is given to modern methods of welding, heat treatment of high-carbon steels, machine-shop construction, the grouping of machines, and methods followed in standardizing production.

1.—FOUNDRY PRACTICE. One hour credit. Both semesters, three hours per week. Molding, and management of the cupola furnace and brass furnace. Practice in melting and pouring iron and nonferrous alloys. Each squad of students is required to have entire charge of the melting and casting of a heat of iron at least once during the course. Required of mechanical-, electrical- and chemical-engineering students. Rocklund.

2.—PATTERN MAKING. One hour credit. Both semesters, three hours per week. The principles of pattern making are studied in a practical way by having each student make patterns that are actually used in the foundry. Required of students in mechanical, electrical and chemical engineering. F. E. Jones.

3.—FORGING. One hour credit. Both semesters, three hours per week. Complete course, including stock calculations, bending, drawing, welding, tempering, and hardening. Required of all excepting architectural students. Wiltfong.

4.—MACHINE SHOP AND PATTERN MAKING OR MOLDING. One hour credit. Second semester, three hours per week. This is an abbreviated course arranged for students who do not take the regular courses 1, 2, and 5. The work includes a half semester of bench work in the machine shop, alternating with a half semester of either pattern making or molding. Required of students in civil and mining engineering. White and F. E. Jones or Rocklund.

5.—BENCH WORK. One hour credit. First semester, three hours per week. A machine-shop course in the use and care of tools; practice in filing, chipping, drilling, and riveting. Required of students in mechanical, electrical, and chemical engineering. White.

6.—MACHINE TOOL WORK I. One hour credit. Second semester, three hours per week. Principally lathe work. Includes cutting off stock, centering, straight and taper turning and thread cutting; turning steel, wrought iron, cast iron and brass. Required of students in mechanical, electrical, chemical and mining engineering. White.

7.—MACHINE TOOL WORK II. One hour credit. Second semester, three hours per week. Use of planer, shaper, milling machine, boring mill, turret lathe; laying out and making machine parts from the drawing; gear cutting. Required of students in mechanical engineering. White.

8.—ADVANCED MACHINE SHOP PRACTICE. One hour credit. First semester, three hours per week. Tool making. Hardening and tempering; grinding; autogeneous welding; jig making; preparing and using high-speed and alloy steels; assembling machinery. Required of students in mechanical engineering. White.

MATHEMATICS.

Professor VAN DER VRIES.
Professor ASHTON.
Assistant Professor JORDAN.
Mr. WHEELER, Instructor.
Mr. LEFSCHETZ, Instructor.
Mr. LARSEN, Instructor.

1.—SOLID GEOMETRY. Two hours credit. Second semester, two hours, at 11:30. The usual theorems and constructions of standard textbooks and applications to the mensuration of surfaces and solids. Larsen.

2.—COLLEGE ALGEBRA. Three hours credit. First semester, three hours, 8:30, 9:30, 10:30, 2:30, 3:30; second semester, three hours, 8:30. Review of elementary algebra; graphic representation, logarithms, determinants. Required of all Freshmen in the School of Engineering. Jordan, Wheeler, Lefschetz, and Larsen.

3.—PLANE TRIGONOMETRY. Two hours credit. First semester, two hours, 8:30, 9:30, 10:30, 2:30, 3:30; second semester, two hours, 8:30. The six trigonometric functions, principal formulas of plane trigonometry, solution of triangles and practical problems. Required of all Freshmen in the School of Engineering. Jordan, Wheeler, Lefschetz, and Larsen.

4E.—ANALYTIC GEOMETRY. Five hours credit. First semester, five hours, at 9:30; second semester, five hours, 8:30, 9:30, 10:30, 2:30. Elementary theory of equations, Horner's method, the straight line and circle, conic sections, higher plane curves, solid analytic geometry. Required of all Freshmen in the School of Engineering. Ashton, Jordan, Wheeler, and Lefschetz.

5E.—CALCULUS I. Five hours credit. First semester, five hours, 8:30, 10:30, 11:30; second semester, five hours, at 9:30. Differential calculus, applications to geometry and mechanics, maxima and minima, integral calculus, simple applications to length, areas, and volumes. Required of all Sophomores in the School of Engineering. Ashton, Jordan, Wheeler, and Lefschetz.

6E.—CALCULUS II. Three hours credit. First semester, three hours, at 11:30; second semester, three hours, 8:30, 9:30, 10:30. Applications of the calculus to problems of solid geometry, double and triple integration, applications to areas, volumes, centers of gravity, and moments of inertia; simple differential equations. Required of all Sophomores in the civil, electrical, and mechanical courses. Ashton, Jordan, and Lefschetz.

57E.—SELECTED TOPICS IN ENGINEERING MATHEMATICS. Second semester, three hours, at 11:30. Complex numbers and vectors, exponential and trigonometric series, hyperbolic functions, differential equations of electrical and mechanical engineering, empirical curves, methods of approximation and numerical calculation. The course may be modified to suit the needs of the class. Optional for Juniors, Seniors, and graduates. Jordan.

For other courses in mathematics, see The College.

MECHANICAL ENGINEERING.

Professor WALKER.
Associate Professor SIBLEY.
Associate Professor SLUSS.
Assistant Professor GARVER.

1.—MACHINE DRAFTING. One hour credit. Sophomore, first semester, M. or Tu., 1:30 to 4:30, three hours. Making of working drawings from sketches of assembled parts, followed by an assembly drawing from detailed working drawings. Garver.

2.—MECHANISM. Three hours credit. Sophomore, first semester, Tu. Th., at 9:30, and F., 1:30 to 4:30. A study of the motion of machine parts and of methods of transmission of motion by gears, belts, cams, and links. Recitations and drawing for mechanical-engineering students. Text, Sibley's Pure Mechanism. Garver.

3.—ELEMENTARY MACHINE DESIGN. Three hours credit. Sophomore, second semester, M. W., at 9:30; Tu., 1:30 to 4:30. Design of representative machine parts and study of their relative motions. For electrical-engineering students. Garver.

4.—STEAM MACHINERY.—Two hours credit. Sophomore, second semester, two hours, Tu. Th., at 10:30. (*a*) Fuels, combustion, and steam generation. (*b*) A study of boiler and engine types. Principal text, Heat Engines, by Allen and Bursley. Required of electrical- and architectural-engineering students. Sluss.

5.—ENGINES AND BOILERS. Three hours credit. Sophomore, second semester, M. W. F., at 9:30; and five exercises in the steam laboratory, Sat., 8:30 to 12:30. A brief study of the general problem of steam power generation from the standpoint of the installing engineer. Text, Heat engines, by Allen and Bursley. Required of civil-engineering students. Physics 1E is a prerequisite. Garver.

6.—STEAM ENGINEERING. Four hours credit. Sophomore, second semester, M. W. F., at 8:30, and W. Th., 1:30 to 4:30. Elements of steam machinery, with special reference to combustion of fuels, boiler types, and engine mechanism, including the study of valve gears. Laboratory practice in proximate analysis of coal, and flue gas analysis. For mechanical-engineering students. Chemistry 2 is a prerequisite. Sluss.

50.—MACHINE DESIGN. Two hours credit. Junior, second semester, Tu. Th., at 10:30, and M. Th., 1:30 to 4:30. Solution of problems in the design of general machine parts, including cylinders, plates, springs, riveted joints, bearings, journal shafts, gears, pulleys, and belts. Lectures, recitations, and drawing. Garver.

51.—THERMODYNAMICS. Three hours credit. Junior, first semester, M. W. F., at 8:30. The relation between heat and mechanical energy; theory of heat engines. Must be preceded by Physics 1E and calculus. Required of mechanical-engineering students. Walker.

52.—HEAT-ENGINE THEORY. Three hours credit. Junior, first semester, M. W. F., at 9:30. A course for electrical-engineering students, treating the science of thermodynamics more briefly than in the preceding course and including engine applications. Garver.

53.—MECHANICS OF HEAT ENGINES. Two hours credit. Junior, second semester, two hours, Tu. Th., at 9:30. Valve gears and governors of steam and internal combustion engines and turbines. Centrifugal inertia and shaking forces of the moving parts. Required of electrical-engineering students. Course 52 is a prerequisite. Sibley.

54.—HEATING, VENTILATING AND COOLING. Two hours credit. Junior, second semester, two hours, at 11:30. Laws of heat transfer, amount of air required for ventilation, methods and apparatus employed in modern buildings, central heating plants. Sibley.

55.—REFRIGERATION. Three hours credit. Optional, first semester, M. W. F., at 9:30. Principles of mechanical refrigeration. Ice-manufacturing and cold-storage plants from the standpoint of American practice.

Recitation, designing-room work, and laboratory exercises with ammonia machine. Sluss.

56.—STEAM-ENGINE AND TURBINE DESIGN I. Three hours credit. First semester. Two hours recitation and three hours drawing per week. Includes a brief review of the thermodynamics of engines and turbines. Determination of sizes for given horsepower; methods of compounding, regulation and balancing; study of details, including valves and valve gears, cylinders, rotating and reciprocating parts of engines, and nozzles, blades, and rotors of turbines. Required of mechanical-engineering students. Sibley.

57.—STEAM-ENGINE AND TURBINE DESIGN II. Three hours credit. Second semester. Application of principles covered in course I to the design of special types. Optional for mechanical-engineering students. Sibley.

58.—INTERNAL-COMBUSTION MOTORS I. Three hours credit. Senior, first semester, M. Tu., 1:30; W. Th., of alternate weeks, 1:30 to 4:30. General theory and practice of gas-engine design and construction. Sibley.

59.—INTERNAL-COMBUSTION MOTORS II. Three hours credit. Senior, optional, second semester, by appointment. Application of principles covered in course I to the design of special types of gas-engines. Sibley.

60.—SHOP METHODS AND EQUIPMENT. One and one-half hours credit. Second semester, Friday at 10:30. One hour recitation and three hours laboratory per week. A study of the design, construction and operation of the modern machine shop. Small tools and equipment; machine tools and shop layouts, safety devices; the routing and tracing of work; theory of time studies and instruction-card writing; cost accounting. Sibley.

61.—STRUCTURAL DESIGN. First semester, M. W. F., at 11:30. Stresses in steel and reinforced concrete buildings, and design of members of the structure; design of chimneys, bins, and retaining walls. Optional for Seniors. Sibley.

62.—INDUSTRIAL-PLANT DESIGN. Three hours credit. Second semester, nine hours by appointment. Planning of manufacturing plants; location, transportation; routing of work; handling material. Senior optional. Sibley.

64.—MECHANICAL LABORATORY. One hour credit. First semester, Junior, W. or Th., 1:30 to 4:30. Calibration of thermometer and indicator springs, physical properties of lubricating oils, valve setting, commercial testing of boilers, engines, and pumps. For mechanical-engineering students. Sluss and Garver.

65.—POWER LABORATORY. One and one-half hours credit. Senior, second semester, M. or Tu., 1:30 to 4:30. Calibration of apparatus, fuel testing, laboratory tests of steam and gas prime movers, complete power-plant test. Outside preparation of preliminary and final reports. Prerequisites, mechanical-engineering 4, 52 and 53. For electrical-engineering students. Sluss.

66.—HEAT-ENGINE LABORATORY. One and one-half hours credit. Senior, second semester, M. or Tu., 1:30 to 4:30. Study of experimental engineering methods and their application to complete tests of boilers, steam and gas prime movers, compressors, and refrigerating units. Drill in report writing, and outside reading of literature bearing on power development. Prerequisites, mechanical-engineering 6, 51, and 56. For mechanical-engineering students. Sluss.

67.—THESIS. Three hours credit. Senior, both semesters, Friday, 1:30 to 4:30. Sibley and Sluss.

68.—SUMMER VACATION WORK. Two months to be spent in regular work in some shop or manufacturing plant of good standing. A report on this work, with a certified statement from the shop foreman or the superintendent, must be presented before credit can be given.

MECHANICS.

Professor RICE (H. A.).
Professor WILLIAMS.
Assistant Professor BROWN.
Assistant Professor ROBERTS.
Assistant Professor JONES (J. O.).

50.—MECHANICS. Five hours credit. Junior, first semester, five hours, at 9:30, 10:30, 11:30; second semester, 10:30. A study of the laws of statics and dynamics. Action of forces upon bodies, and the resulting motions. Required of all engineering students. Prerequisite, calculus I. Brown and Roberts.

51.—STRENGTH OF MATERIALS. Four hours credit. Junior, first semester, four hours, 8:30; second semester, 8:30, 9:30, 10:30. The theory of resistance to stress and application to engineering construction. Required of all engineering students. Prerequisite, mechanics 50. Brown, Roberts, J. O. Jones.

52.—TESTING OF MATERIALS. One hour credit. Junior, second semester, four hours, M. W. Th. or F., afternoon, or Sat. morning. A laboratory course to accompany course 51. The testing of iron, steel, wood, and other materials of construction for resistance to tension, compression, torsion, bending, and shearing. Experimental determination of the limits of safe loading. The testing of paving brick. Brown and Roberts.

53.—GRAPHIC STATICS. Two hours credit. Junior, second semester, nine hours, 1:30 to 4:30. The properties of equilibrium polygons and other methods of representing the actions of forces, with application to the determination of stresses in beams, trusses, and arches. Lectures and drawing. Prerequisite, mechanics 50. Brown.

54.—ENGINEERING MATERIALS. Two or five hours credit. First semester, ——— hours, by appointment. A study of the methods of manufacture of structural materials and the different means and machines used in their testing. Opportunity will be given for specilization along some particular line, if desired, and considerable experimental work may be done in the laboratory. Recitations, lectures, library, and laboratory work. Optional for Seniors. Prerequisite, mechanics 51. H. A. Rice.

55.—HYDRAULICS. Three hours credit. First semester, 9:30; second semester, three hours, 9:30 to 10:30. A study of the laws governing the pressure and flow of liquids. Calculation of the flow through pipes and over weirs. The principles and types of pumping and hydraulic power machinery. Required of Junior civil and Senior mechanical-engineering students. Prerequisite, mechanics 50. J. O. Jones.

56.—HYDRAULIC LABORATORY. One hour credit. First and second semesters, two hours, M. W. or F., 3:30 to 5:30. A course to accompany course 55. Experimental work with the flow of water over weirs and through orifices and pipes, and in testing hydraulic machinery. Required of Junior civil and Senior mechanical-engineering students. J. O. Jones.

57.—HYDRAULIC CEMENT. One hour credit. Second semester, two hours, M. or Th., 3:30 to 5:30. A laboratory course in testing hydraulic cements and making comparison of their qualities. Reading, experimental work, and reports of tests made. For Senior civil-engineering students. Prerequisite, civil engineering 64. Williams.

58.—HYDRAULIC POWER. Three hours credit. First semester, by appointment. Water-power development. Rainfall and runoff, stream flow, preliminary plant layout, selection of standard water turbines, turbine design. Senior optional. J. O. Jones.

METALLURGY.

Associate Professor WHITAKER.
Mr. PARKHURST, Instructor.

57.—ASSAYING AND METALLURGICAL ANALYSIS. Three or five hours credit. Second semester, five or ten hours, Tu. Th., 1:30 to 3:30. The first half of the semester is devoted to the fire assay of gold, silver, and other metals; the second half to the volumetric assay of ores and furnace products. Junior mining-engineering students are required to take the entire course, carrying five credits; the Senior chemical-engineering students are required to take fire assaying the first half of the semester, and will receive three credits. Whitaker and Parkhurst.

61E.—METALLURGY I. Three hours credit. First semester, three hours, at 11:30. General metallurgy and the metallurgy of iron and steel. Lectures and recitations. Must be preceded by chemistry 3. Required of Junior mechanical-engineering students and Senior chemical-engineering students. Whitaker.

62E.—METALLURGY II. Three hours credit. Second semester, three hours, M. W. F., at 9:30. Metallurgy of lead, zinc, and copper, followed by that of silver, gold, mercury, and tin. Required of Senior mining- and chemical-engineering students. Prerequisite, chemistry 3. Whitaker.

63.—METALLURGICAL LABORATORY. Either semester, two hours, by appointment. Pyrometric and calorimetric measurements, preparation of silicates and alloys, oxidation and reduction reactions, amalgamation, chlorination, cyaniding and leaching, etc. Optional for Juniors, Seniors, and graduate students who have taken or are taking course 61E or course 62E. Whitaker.

64E.—IRON AND STEEL. Two hours credit. Second semester, two hours, Tu. Th., 9:30. A repetition in briefer form of course 61E. Required of Junior mining-engineering students. Whitaker and Parkhurst.

65E.—GENERAL METALLURGY. Two hours credit. First semester, Tu. Th., 11:30. Physical properties of metals and alloys, thermal analysis, the measurement of high temperatures, refractories, slags, matte bullion, typical metallurgical operations. Required of chemical engineers. Whitaker.

MINERALOGY.

Professor HAWORTH.
Assistant Professor TODD.

10.—ELEMENTARY MINERALOGY I. Five hours credit. Sophomore, second semester, ten hours, 3:30 to 5:30. A brief course in crystallography, blowpipe analysis, and systematic mineralogy, consisting of lectures and laboratory work. Todd.

61.—PETROGRAPHY. Five hours credit. First semester. This course includes a study of the mineralogical and chemical composition of rocks, their origin, structural features, and classification. Haworth.

Other courses in mineralogy are open to engineering students as optionals. For these, see The College.

MINING ENGINEERING.

Professor TERRILL.
Professor HUMBLE.
Mr. GRIDER, Instructor.

1.—MINING METHODS. One hour credit. Both semesters, M. F., at 11:30. Two lectures per week on methods of prospecting, developing, and working mineral beds, masses, veins, etc. Study of methods used in mining regions for certain classes of deposits. Includes a visit to the lead-zinc district of Kansas and Missouri, and a report. Terrill.

50.—MINE SURVEYING. One hour credit. First semester, three hours per week. Instruments and methods used for underground traverse and connection surveys; shaft plumbing and special problems. Field work includes survey of tunnels under campus and actual mine surveys. Prerequisite, civil engineering 1, 2, and 3. Terrill.

51.—EXCAVATION AND EXPLOSIVES. Two hours credit. Second semester, Tu. Th., 9:30, and a minimum of ten three-hour periods of laboratory work. (*a*) Excavating machinery and tools. Excavation, drilling, tunneling, shaft sinking, stripping, supporting excavations with pillars, timber, masonry, rock filling, etc. Handling and transporting material. Explosives, composition, manufacture and use. (*b*) Practice in the above carried out in the experimental mine. Grider.

52.—MINING LAW. One hour credit. Second semester, alternate years. Outline of the laws relating to the mining industries. Recitations and lectures. Humble.

53.—ORE DRESSING I. Two hours credit. First semester, one lecture and three hours of laboratory work. Preliminary breaking, roll crushing, jigging, coarse screening, coal washing. Required of students in coal and metal mining. Terrill.

54.—METAL MINING. Two hours credit. First semester, Tu. Th., 11:30. Methods of prospecting and mining all kinds of mineral deposits; study of special methods, and costs of working large ore deposits; ventilation; control and measurement of air currents; surface and underground haulage; compressed-air application. Prerequisites, mining engineering 1 and 51. Grider.

55.—MINING HYDRAULICS. Two hours credit. First semester, M. W., at 11:30. Theory of hydraulics, flow through orifices, tubes, and pipes; flow in conduits and rivers; measurement of water; hydraulic motors, pumps and hydraulic machinery; gravel deposits, drift mining, ground sluicing, hydraulic mining, river mining, dredging, and drainage. Grider.

56.—MINE PLANT AND MILL DESIGN I. Two hours credit. First semester. One lecture and three hours drafting. Graphical statics, beams and trusses, building materials, foundations; calculations relating to machine parts, transmission of power by bands, riveted joints, etc.; elementary design of mine buildings, trestles, ore bins, headframes, etc. Grider.

57.—MINE ADMINISTRATION. One hour credit. Second semester. Business management, mine accounts and cost sheets. Mine accidents, care of sick and injured. Sanitation of camps. Terrill.

58.—ORE DRESSING II. Four hours credit. Second semester. Two lectures and six hours laboratory. Fine crushing and screening machinery, sand and slime concentration, flotation, stamp milling, amalgamation, cyanidation, classification, regrinding, mill sampling, miscellaneous processes of separation, and accessory apparatus. Required of students in metal mining. Terrill.

59.—MINE EXAMINATION AND REPORTS. One hour credit. Second semester, three hours by appointment. Sampling tools; sampling fissure veins, coal seams, placer deposits, tailings, mill products, gases, liquids, etc.; preparing samples for the assayer; recording assays, assay maps and surveys; underground, milling and metallurgical losses; estimating tonnage; mine examination and camp equipment; writing reports. Grider.

60.—PROFESSIONAL THESIS. Two hours credit. This may be description of a mining or metallurgical plant, or of a mining district, or may be work done in connection with course 63, or 65, or may be founded upon research work done at the University. Terrill and Grider.

61.—COAL MINING I. Two hours credit. First semester, Tu. Th., at 11:30. Methods of working coal beds and handling coal. Properties of mine gases, safety lamps, explosives, ventilation, causes and prevention of explosions. Terrill.

62.—COAL MINING II. Three hours credit. Second semester, M. W. F., at 9:30. Systems and methods of working coal, extraction, haulage, hoisting, coal-cutting tools, coal-cutting machinery, excavating machinery, mine cars and tracks, etc.; surface plants. Prerequisite, mining engineering 1 and 61. Terrill.

63.—MINE PLANT AND MILL DESIGN II. Three hours credit. Second semester, 1 lecture and 6 hours drafting. Optional for Senior and graduate students. Advanced course in design, construction and installation of mine plants, concentrating mills, machinery, headframes, ore bins, dams, fans, foundations, tramways, flumes, sluices and pressure boxes. Preparation of working drawings, bills of materials, specifications and estimates. Prerequisite, mining engineering 56. Grider.

64.—MINING ENGINEERING. Three hours credit. First semester. The economic importance of geological irregularities affecting mine operations, of mine maps in following the ore, of choosing methods and locating openings, and of conditions affecting cost and production of the metals and nonmetals. Grider.

65.—SUMMER WORK. Each candidate for a degree is required to give evidence of having had experience in some phase of mining work. This may be gained by an investigation of some mining district under the direction of an instructor for a period of six weeks, or by employment in mining work.

66.—ADVANCED ORE DRESSING III. Four hours credit. Second semester, Senior or graduate students. One lecture and 9 hours laboratory work, optional. Principles and schemes of mill processes. Adapting processes to specific ores, each student to choose one of the following for special study: flotation or other concentration method; amalgamation; cyanidation; chlorination; chloridizing roast; or lixiviation methods. Grider.

67.—MINERAL AND PUBLIC LAND SURVEYING. Three hours credit. First semester, Senior and graduate students. Two lectures and one afternoon. (*a*) Mineral land surveying; mining claims, timber, coal and stone lands; dam, mill, tunnel, and reservoir sites; ditch, flume, and pipe lines; preparation and filing legal documents; duties of United States deputy mineral surveyors. (*b*) Subdividing public lands, locating, relocating, and marking corners, making plats, reports, etc. Prerequisite, civil engineering 1 and 2. Grider.

PHYSICAL EDUCATION.

Professor NAISMITH.
Mr. LORENZ, Instructor.

FRESHMAN 1. First half-semester, soccer, football, elementary gymnastics, and track work; second half-semester, basketball, tumbling, apparatus work, swimming.

FRESHMAN 2. First half-semester, apparatus work, swimming, diving, etc.; second half-semester, track athletics, high jump, etc., or lacrosse.

Freshman are required to attend classes three periods per week. Special classes are organized for engineers at such times as the majority can attend.

Additional courses will be arranged for special work and for the prescribed work which can not be done in class.

Every student may receive a thorough medical and physical examination, with the results platted on a chart. When needed, special exercises will be prescribed.

Every student who uses the gymnasium, or who is a candidate for any University team, must pass a satisfactory medical and physical examination.

PHYSICS.

Professor KESTER.
Associate Professor RICE (M. E.).
Assistant Professor STIMPSON.
Assistant Professor SMITH (T. T.).
Mr. WHITTEMORE, Instructor.

1E.—GENERAL PHYSICS. Five hours credit. First semester, four recitations at 11:30; two hours laboratory at assigned periods; second semester, four recitations at 10:30, two hours laboratory at assigned periods. A fundamental course of experimental lectures, recitations, and problems. Prerequisites, plane trigonometry and some knowledge of analytical geometry and calculus. First semester, M. E. Rice and other instructors; second semester, T. T. Smith and other instructors.

2E.—GENERAL PHYSICS. Five hours credit. Second semester, four recitations, at 11:30, two hours laboratory at assigned periods; first semester, four recitations, at 10:30, two hours laboratory at assigned periods. A continuation of course 1E. Second semester, M. E. Rice and other instructors; first semester, T. T. Smith and other instructors.

52.—THEORY OF ELECTRICITY AND MAGNETISM. Three hours credit. First semester, M. W. F., at 11:30. M. E. Rice.

60E.—ELECTRICAL MEASUREMENTS I. One and one-half hours credit. First semester, three hours per week. M. Tu. of alternate weeks, 1:30 to 3:30. A laboratory course coördinate with 52. M. E. Rice.

61E.—ELECTRICAL MEASUREMENTS II. One and one-half hours credit. Second semester, three hours; M. Tu. of alternate weeks, at 1:30 to 3:30. Continuation of course 60E. M. E. Rice.

For other courses in physics, see The College and The Graduate School.

ROMANCE LANGUAGES.

Assistant Professor WINTER.
Miss GARDNER, Instructor.

FRENCH.

1.—ELEMENTARY FRENCH I. Five hours credit. First semester, at 10:30. Grammar (Fraser and Squair), and easy reading. Drill in pronunciation, accidence, and easy syntax. Gardner.

2.—ELEMENTARY FRENCH II. Five hours credit. Second semester, at 10:30. A continuation of course 1. Reading of simple prose texts, with exercises in dictation and elementary composition. Gardner.

(Instead of taking course 3, engineering students should take course 5. Those wishing course 4 may take it either semester in the College.)

5.—SCIENTIFIC FRENCH. Three hours credit. First semester, at 11:30. Translation of some scientific text. Reading and reports of current French scientific and technical periodicals. The aim of this course is to give the students a reading knowledge of the French language of science for practical use in research work. Prerequisites, courses 1 and 2. Gardner.

SPANISH.

1.—ELEMENTARY SPANISH I. Five hours credit. First semester, five hours, 8:30, 9:30, 1:30; also second semester, five hours, at 1:30. An outline of grammar (Olmsted and Gordon). Reading of short stories. Elementary composition. Winter and Gardner.

2.—ELEMENTARY SPANISH II. Five hours credit. Second semester, five hours, 9:30 or 1:30. Grammar and composition. Reading of easy modern prose. Carrión-Aza, Pérez Galdós, Ibáñez, etc. Winter and Gardner.

For advanced courses in Spanish, see The College.

TECHNICAL REPORTS AND THESES.

Special written reports are required from each student at certain times during his course of study, generally one in each semester of the Sophomore year, one in the Junior year, and one in the Senior year. A student enrolled for technical report I, II, III, or IV confers with his instructor for assignment of the subject on or before October 15 for the first semester, and on or before March 15 for the second semester. The finished reports must be in the instructors' hands by January 15 and May 15 of the respective semesters. Each report counts for one-half credit.

A special thesis is required of each student before his graduation. (See "Thesis" in the description of courses of the professional departments.)

Standard forms for the make-up of technical reports, theses, and other written papers are specified in an official circular to be had at the Dean's office.

SUMMER WORK.

In several of the courses of study practical work in one or two summers is required. This work is not measured in terms of credit hours, although in fixing the requirements for graduation one or two additional credit hours are required in those courses of study which do not include summer work.

INSPECTION TRIPS.

As a valuable adjunct to resident study at the University, inspection trips to various engineering works are required to be taken by students with their instructors. Such trips may be made to large machine shops, power plants, steam or electric railways, lighting systems, city waterworks, sewerage systems, industrial chemical plants, cement works, mining plants, or smelters. Architectural-engineering students are expected to visit important buildings in course of construction. These trips may be made during regular sessions of the school or during vacation. Parties sometimes travel as far as Chicago or St. Louis. The trips requiring absence from other work and those of considerable expense are indicated in the programs of required courses of study.

ENGINEERING EXPERIMENT STATION.

STATION STAFF.

FRANK STRONG, Ph. D., President.
P. F. WALKER, M. M. E. (Director), Mechanical Engineering.
GEORGE C. SHAAD, E. E., Electrical Engineering.
HERBERT A. RICE, C. E., Mechanics and Civil Engineering.
GOLDWIN GOLDSMITH, Ph. B., Architectural Engineering.
A. C. TERRILL, E. M., Mining Engineering.
W. A. WHITKAER, A. M., Chemical Engineering.

PURPOSES.

This department of University activity has been established for two reasons: first, to correlate and group together in a more systematic way the results of scientific investigation that heretofore has been done under the various departments; second, to foster, enlarge, and direct this work, especially along lines of value to this state, and to supervise the publication and distribution of the results of engineering and industrial research work.

The work completed and published up to the present time has been done mainly by members of the teaching staff. It is described in detail in Section XII of the complete Catalog. Lists of all publications and of those soon to be issued are given. All communications relative to the Station and its work should be addressed to the Director.

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